

STUDIES ON PARMELIA SUBGENUS PARMELIA

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Introduction

At least 250 distinct species, most of which occur in the tropics, are included in *Parmelia* subgenus *Parmelia*. They are generally characterized by lobes that are narrow (0.5–4.0 mm. wide), sublinear to subirregular, and often apically truncate. The apothecia are adnate and usually imperforate, and there are rhizines over all or most of the lower surface. This broadly delimited group has usually been called section *Hypotrachyna* Vain., but we propose to recognize it as a subgenus, subgenus *Parmelia*, typified by *P. saxatilis* (L.) Ach.

Subgenus *Parmelia* is coordinate with subgenus *Amphigymnia* (Vain.) Dodge, the broad-lobed Parmelias, and subgenus *Xanthoparmelia* (Vain.) Hale, comb. nov., based on section *Xanthoparmelia* Vain. (1890, p. 60), with *Parmelia conspersa* (Ach.) Ach. as the type species. The Xanthoparmelias are similar in configuration to many species in subgenus *Parmelia*, but they differ in being saxicolous, always containing usnic acid, and having simple rhizines. The brown Parmelias (sections *Melanoparmelia* Zahlbr., *Vainioellae* Gyel., and *Olivascentes* (Hue) Hillm.) are excluded from subgenus *Parmelia*, although we have not yet decided on their exact position in the genus.

In the course of preparing a world monograph of subgenus *Parmelia*, we have examined the types of most of the described species and reevaluated the subgeneric classification. This preliminary study will present the outlines of a new sectional classification, descriptions of 52 new species, 2 new combinations, and 4 new names, and preliminary keys to the species in the major sections. A final monograph must await more extensive study of general herbarium material as well as field work, since many species are still known only from their type localities.

This study has been made possible by the prompt and generous cooperation of the curators and directors of museums and university herbaria in lending type specimens and other valuable collections and in rendering assistance and providing facilities for study during visits. They include Dr. Sten Ahlner (Naturhistoriska Riksmuseet, Stock-

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Morphological Characters

The following are the more important morphological characters that we have found in subgenus *Parmelia*. Some of them have been overlooked or poorly understood by previous workers and will be discussed in detail.

1. Rhizines: Are produced more or less uniformly over the entire lower surface in the majority of species. Certain species with subrotund subirregular lobes, however, may have a narrow though distinct bare or papillate zone around the margins. Three major types of rhizines may be distinguished: simple and unbranched or rarely

sparsely furcate; dichotomously and usually richly branched; and squarrosely branched (fig. 1). Branching of the rhizines has proved

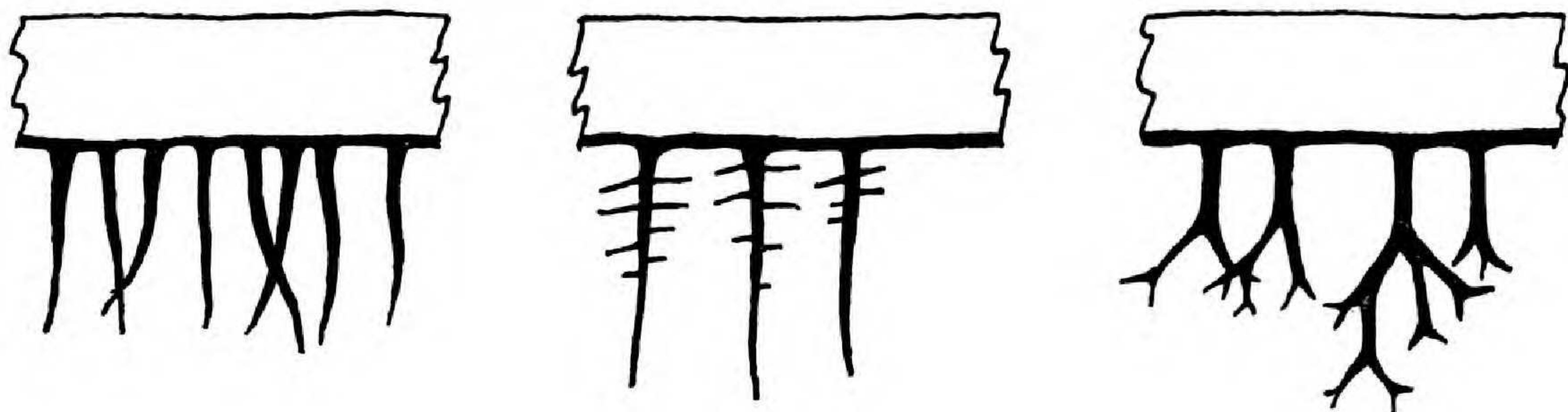


FIGURE 1.—Schematic drawings of the three types of rhizines: Simple, squarrosely branched, and dichotomously branched (left to right).

to be one of the most important characters on which our proposed sectional classification is based.

2. Cilia: Two types of ciliate outgrowths occur on the margins of lobes, simple cilia and bulbate cilia. Simple cilia, comparable to those known in *Anaptychia* or *Cetraria*, occur in at least 34 species of subgenus *Parmelia* (pl. 1). These same species usually have a black lower surface and simple rhizines (e.g., *P. dissecta* Nyl. and *P. tiliacea* (Hoffm.) Ach.). Bulbate cilia differ from simple cilia in having a conspicuously inflated base. This structure (pl. 1) is known in some 45 species, all of them tropical. It has not been consistently recognized by lichenologists, although commemorated in names such as *P. circumnodata* Nyl. Bulbate species may have branched or unbranched rhizines and a pale or black lower surface. Bulbate cilia may merely be modifications of simple cilia, but they are distributed around the lobes with much greater regularity. Chemical data (table 1) indicate that simple-ciliate and bulbate-ciliate species are far more closely related to each other than to any other groups in the subgenus. Both types of cilia are probably related to rhizines and, as in the case of rhizines, are of very great importance in subgeneric classification.

3. Lobules: These structures have usually been confused with isidia. They apparently originate as isidia but soon begin to flatten and grow horizontally (cf. *Parmelia ensifolia*, pl. 7). At maturity they are more or less dorsiventral and often ciliate. Lobules are rather rare and best seen in *P. culmigena* Zahlbr., *P. digitata* Lynge, *P. horrescens* Tayl., or *P. ensifolia* Kurokawa.

4. Pustules: Are coarse papillar outgrowths from the upper cortex. They are extremely fragile and seem to lack the thalloid structure of isidia. They may remain intact, as in *P. dactylifera* Vain., or at length erupt or burst open apically and form dense pustular masses, with little or no tendency to become soresiate (pl. 1). If coarse

soredia form, they are not so dense as to obscure the basic pustular structure. Typically pustulate species include *P. aurulenta* Tuck., *P. endochlora* Leight., *P. formosana* Zahlbr., and *P. spumosa* Asah.

5. Maculae: Are submacroscopic white dots uniformly scattered in the upper cortex. They are apparently caused by irregular clumping of algal colonies in the gonidial layer. They are at times difficult to recognize, and most lichenologists have in fact overlooked them. Maculae are nevertheless important, especially at the species level. They occur in such well-known species as *P. laevigata* (Sm.) Ach. and *P. tiliacea* (Hoffm.) Ach.

6. Pseudocyphellae: Here we refer to actual pores in the upper cortex. There are apparently two different kinds. One is found in species related to *P. borrieri* (Sm.) Turn., where the pores are distinctly orbicular or elliptical and scattered irregularly in the upper cortex (pl. 1). They are correlated with the presence of simple rhizines and P— acids (gyrophoric acid, lecanoric acid, and fatty acids). A second type of pore is found in species related to *P. saxatilis* (L.) Ach., where the pores are angular or effigurate and are arranged in more or less definite patterns on the cortex and margins of lobes (pl. 1). These species usually contain a P+ acid (protocetraric or salacinic acid) and have a black lower surface with squarrosely branched rhizines.

7. Reticulation: The upper cortex of a small group of species related to *P. reticulata* Tayl. is finely reticulately maculate and fissured (pl. 1). Initially the cortex is maculate to the margins of the lobes and at maturity actual fissuring usually occurs. Many species of *Parmelia* are irregularly or more or less reticulately cracked on older lobes, but young lobes lack any reticulation. Reticulate species always have a black lower surface and simple to squarrosely branched rhizines.

8. Isidia and soredia: These two characters are well known to lichenologists through the work of Du Rietz (1924a) and require no further discussion here. They are valuable species characters in *Parmelia* but have no value at the sectional level.

9. Apothecia: These characters offer little basis for classification in subgenus *Parmelia*. Spores are uniformly small, generally only 6–18 μ in length, and attain a length of 30 μ in only a few species such as *P. leucopis* Krempfh., *P. mutata* Vain., and *P. versiformis* Krempfh. Except for *P. cetrata* Ach., *P. homotoma* Nyl., and *P. reticulata* Tayl., the apothecial disc is never perforate. There is little significant variation in degree of adnation on the thallus, except in such unusual pedicellate species as *P. peruviana* Nyl. Coronate exciples and basal retrorse rhizines are often found on the apothecia of species with

bulbate cilia. *Parmelia carporrhizans* Tayl., a ciliate species, is densely rhizinate at the base of the apothecia.

10. Anatomy: The internal anatomy is for the most part uniform. The total thickness of the thallus varies from about 60 μ to 250 μ ; the cortex is often thinner and more fragile than in subgenus *Amphigymnia*. Peculiar moniliform cells are found in the medulla of *P. galbina* Ach., *P. obsessa* Ach., and *P. metarevoluta* Asah., three closely related species (cf. Asahina, 1952, p. 98). Future workers may place greater reliance on internal characters, but for the time being this approach seems unrewarding.

Chemical Characters

The taxonomy of subgenus *Parmelia* cannot be studied fully without the use of chemical tests. This does not imply that we are accepting or deliberately describing so-called "chemical species." Anyone who works with a genus such as *Parmelia*, which has a wide

TABLE 1.—Number of species in the various sections and subsections containing 19 important chemical substances.

| | Section Parmelia | | Section Irregu- lars | Section Imbricaria | | Section Cyclo- chella | Section Hypotra- chyna |
|-------------------------|------------------------|-------------------------|----------------------------|--------------------------|--------------------------|-----------------------------|------------------------------|
| | Subsection Parmelia | Subsection Simplices | | Subsection Bicornutae | Subsection Imbricaria | | |
| Number of species | 30 | 25 | 10 | 46 | 33 | 46 | 83 |
| Gyrophoric acid | — | 5 | — | 7 | 4 | — | 6 |
| Lecanoric acid | — | 10 | — | 3 | 4 | 2 | ^a [5] |
| Salacinic acid | 28 | — | 7 | 10 | 4 | 3 | 8 |
| Stictic acid | — | — | — | 2 | 2 | 5 | 1 |
| Norstictic acid | — | — | — | 4 | 2 | — | 5 |
| Protocetraric acid | 2 | — | — | 3 | 1 | 12 | 15 |
| Usnic acid | — | — | — | 18 | 1 | 9 | 12 |
| Rhodophyscin | — | — | — | — | — | 3 | 9 |
| K— pigments | — | — | — | — | 11 | 5 | 5 |
| Olivetoric acid | — | — | — | — | — | — | 4 |
| Cryptochlorophaeic acid | — | — | 1 | — | — | — | 1 |
| Evernic acid | — | — | — | — | — | 1 | 5 |
| Divaricatic acid | — | — | — | — | — | 8 | — |
| Perlatolic acid | — | — | — | — | — | 1 | — |
| Alectoronic acid | — | — | — | — | — | — | 7 |
| Barbatic acid | — | — | — | — | — | 1 | 11 |
| Lichexanthone | — | — | — | — | — | — | 7 |
| KC+ unknown ("livida") | — | — | — | — | — | 1 | 5 |

^a Lecanoric acid in section Hypotrachyna is an accessory component with evernic acid.

variety of color tests and chemical constituents, soon realizes that the lichen acids are absolutely indispensable aids in species identification. We have tested all specimens with the usual microchemical methods of Asahina and Shibata (1954). Detailed discussions of problematic or unidentified substances encountered will be delayed until a final monograph is completed. In the meantime, however, we have prepared a preliminary table showing the number of species within each section or subsection containing each of 19 identifiable lichen substances (table 1). Certain noteworthy features of this table will be discussed below under the various sectional headings.

The color of the thallus and medulla is described for many of the species according to Ridgway's Color Standards and Color Nomenclature (1912); such colors are indicated by the notation R in parentheses.

Subgeneric Classification

A classification for subgenus *Parmelia* is based on results from our own morphological and chemical studies and on reviews of previously proposed classifications, especially those of Vainio (1890, 1923), Gyelnik (1932), and Asahina (1952).

1. Section *Parmelia*
 - Subsection *Parmelia*
 - Subsection *Simplices* Hale & Kurokawa
2. Section *Irregulares* (Vain.) Vain.
3. Section *Imbricaria* (Schreb.) Fr.
 - Subsection *Imbricaria*
 - Subsection *Bicornutae* (Lynge) Hale & Kurokawa
 - Series *Bicornutae*
 - Series *Relicinae* Hale & Kurokawa
4. Section *Cyclocheila* (Vain.) Räs.
5. Section *Hypotrachyna* Vain.

Typification, descriptions, and discussions of these taxa are presented below under appropriate sectional headings. Keys to species in the major sections are included whenever possible in order to show the relationships of the new species to those already known. The keys do not include a small number of rare problematic species that have not yet been characterized. It is anticipated of course that more new species and revisions of names will be made in the final monograph. It should be emphasized that all species names in the keys are based on the actual study of holotype or lectotype specimens.

Key to Sections

1. Cortex pseudocyphellate, with or without effigurate maculae; rhizines simple or squarrose 1. Section **Parmelia** (p. 127)

1. Thallus lacking pseudocyphellae; rhizines simple, dichotomously or squarrosely branched.
2. Lobes more or less rotund; upper cortex uniformly reticulately maculate or fissured to the margin . . . 2. Section *Irregulares* (Vain.) Vain. (p. 129)
2. Lobes sublinear and truncate to subrotund; upper cortex continuous, fissured only on older lobes.
3. Cilia or bulbate cilia present on margins of lobes.
3. Section *Imbricaria* (Schreb.) Fr. (p. 130)
3. Cilia absent.
4. Rhizines simple 4. Section *Cyclocheila* (Vain.) Räs. (p. 147)
4. Rhizines dichotomously branched.
5. Section *Hypotrachyna* Vain. (p. 159)

Subgenus *Parmelia*

Type species: *Parmelia saxatilis* (L.) Ach.

Thallus appressed to adnate, rarely subascending; lobes sublinear to subirregular, rarely broad and rotund, the margins entire and smooth, ciliate, or bulbate-ciliate; undersurface black or brown, uniformly rhizinate to the margins, or, in species with rotund lobes, with a narrow bare or papillate zone, the rhizines simple and unbranched, dichotomously branched, or squarrosely branched. Apothecia more or less adnate, rarely pedicellate, the disc imperforate (except in section *Irregulares*); spores simple, suborbicular to ellipsoid, usually less than 20 μ long.

Parmelia has been proposed as a nomen genericum conservandum with *P. saxatilis* (L.) Ach. as the lectotype species (cf. International Code of Botanical Nomenclature, p. 220, 1961). This has been the unanimous choice as a lectotype for the genus (cf. Dodge, 1959), and we see no objections to it. *Parmelia saxatilis* is therefore the type of subgenus and section *Parmelia*.

1. Section *Parmelia*

Thallus adnate; lobes sublinear, rarely subirregular and subrotund; upper cortex pseudocyphellate, with or without effigurate maculae; lower surface black or brown, the rhizines simple or squarrosely branched.

Imshaug (1957) placed section *Hypotrachyna* Vain. in synonymy under section *Parmelia*. As will be shown below, Vainio's section is based on *P. brasiliiana* Nyl., a tropical species with dichotomously branched rhizines and no pseudocyphellae.

As we previously indicated, there are two quite distinct types of pseudocyphellae in this section, one typically elliptical and correlated

with simple rhizines and the other effigurate-maculate and correlated with squarrosely branched rhizines. They are best treated as two subsections, *Parmelia* and *Simplices*, as follows:

Subsection *Parmelia*

Section *Hypotrachyna* subsection *Myeloleuca* Asah. (1952, p. 24). Lecto-
type: *P. saxatilis* (L.) Ach.

Upper cortex with effigurate maculae; lower surface black, the rhizines squarrosely branched or simple.

Asahina's subsection *Myeloleuca* included all species of subgenus *Parmelia* lacking medullary pigments. We feel that the most suitable choice of a lectotype for this extremely broad subsection would be *P. saxatilis*. According to the International Code of Botanical Nomenclature (Art. 22), the rule of tautonymy applies only to the subgeneric and sectional ranks. Notwithstanding, we prefer to retain the spirit of the Code and use *Parmelia* as a subsectional epithet as well, even though Asahina's subsection *Myeloleuca* is validly published and synonymous.

As we have delimited this subsection, it contains about 30 species. The upper cortex is often ridged with the effigurate pseudocyphellae forming patterns along the ridges (cf. pl. 1, fig. 4). As far as is known, all species contain salacinic acid, except *P. insensitiva* (Magn.) Anders. and *P. pseudosulcata* Gyel., which contain protocetraric acid. Most of the species are confined to montane or subboreal areas in the Northern and Southern Hemispheres, with the greatest abundance in eastern Asia, where at least 15 species have been reported. Most of the Asian species have been summarized by Asahina (1952). There is a small group of Australian species, including *P. tenuirima* Tayl. and *P. signata* Nyl., which have not yet been fully investigated. The common American and European species *P. fraudans* Nyl., *P. omphalodes* (L.) Ach., *P. saxatilis* (L.) Ach., and *P. sulcata* Tayl. are well known.

Subsection *Simplices* Hale & Kurokawa, subsect. nov.

Thallus superne pseudocyphellatus, pseudocyphellis suborbicularibus vel ovalibus, subtus niger vel pallide castaneus, rhizinis simplicibus.

Type species: *Parmelia borrieri* (Sm.) Turn.

This subsection contains at least 25 species, but their taxonomy has not yet been completely worked out. They are found commonly in savannas or dry temperate forests. The pseudocyphellae are similar to those of *P. cetrarioides* (Duby) Nyl., an *Amphigymnia* species. The rhizines are always simple and quite long. The chemistry is extremely simple, the medulla reacting P—, C+ rose or red (gyrophor-

ic or lecanoric acids), or C— (fatty acids). There is very strong correlation between the color of the lower surface and chemical constitution. All species with lecanoric acid, including the well-known *P. subrudecta* Nyl. (*P. dubia* (Wulf.) Schaer.) and *P. rudecta* Ach., have a pale brown lower surface; and all species with gyrophoric acid, such as *P. borreri* (Sm.) Turn. (*P. pseudoborreri* Asah.) and *P. borrerina* Nyl., have a jet-black lower surface. Those with fatty acids have either a pale (e.g., *P. bolliana* Müll. Arg. and *P. canaliculata* Lyngé) or a black lower surface (e.g., *P. appalachensis* Culb. and *P. microsticta* Müll. Arg.) (cf. Culberson, 1962).

2. Section *Irregulares* (Vain.) Vain. (1923, p. 34)

Section *Hypotrachyna* * *Irregularis* Vain. (1890, p. 38).

Section *Reticulatae* Du Rietz (1924b, p. 331).

Lectotype species: *Parmelia reticulata* Tayl.

Section *Hypotrachyna* subsection *Irregulares* (Vain.) Gyel. (1932, p. 224).

Section *Hypotrachyna* subsection *Irregulares* (Vain.) Hillm. (1934, p. 188).

Superfluous combination.

Type species: *Parmelia cetrata* Ach.

Thallus loosely adnate; lobes subirregular, usually broad and rotund; upper cortex reticulately maculate and at maturity reticulately fissured to the margins; lower surface black, the rhizines simple or at maturity squarrosely branched. Apothecia more or less substipitate, the disc perforate or imperforate,

Vainio first proposed *Irregulares* in 1890 as a group name under section *Hypotrachyna* without a designated rank. The obvious lectotype is *Parmelia cetrata* Ach. He proposed two other groups of equivalent rank, *Cyclocheila* (lectotype *P. amazonica* Nyl.) and *Sublinearis* (lectotype *P. brasiliana* Nyl.). These three groups were separated by subtle and overlapping differences in lobe configuration and presence of rhizines, papillae, or a narrow bare zone below along the margins. No lichenologist has successfully employed this classification and most recent workers in fact have rejected it (cf. Asahina, 1952; Maas Geesteranus, 1947).

Almost all lichenologists except Räsänen (1943), however, have overlooked the fact that Vainio radically revised his own classification in a study of Philippine lichens (1923). He eliminated section *Hypotrachyna* and proposed in its place two sections, section *Irregulares* (including the former *Cyclocheila* and *Irregularis*) and section *Sublineares*. This realignment more or less successfully circumvented the difficulties of his former classification by recognizing only two general types of lobe configuration, subirregular and apically rotund and sublinear and truncate.

Du Rietz' section *Reticulatae* was set up parallel with section *Hypotrachyna* Vain. and section *Amphigymnia* Vain. Du Rietz based

the section not only on *P. cetrata* and *P. reticulata* but also on *P. perforata* (Jacq.) Ach., which is heavily maculate but lacks reticulate fissures. If *P. perforata* is excluded and placed in subgenus *Amphigymnia*, section *Reticulatae* corresponds exactly with section *Irregulares*.

This small section is close to *Amphigymnia* in lobation, but the lower surface is usually rhizinate or papillate to the margins. Furthermore, the rhizines are squarrosely branched at maturity, whereas the rhizines of *Amphigymnia* species are always simple and often sparse. There are about ten species in section *Irregulares*, some very widely distributed in temperate and subtropical areas. The commonly collected species are *P. balansae* Müll. Arg., *P. cetrata* Ach., *P. homotoma* Nyl., *P. macrocarpoides* Vain., *P. pilosa* Stein., *P. reticulata* Tayl., and *P. subisidiosa* (Müll. Arg.) Dodge.

3. Section *Imbricaria* (Schreb.) Fr. (1825, p. 242)

Lichen sect. *Imbricaria* Schreb. (1791, p. 767).

Lectotype species: *Parmelia tiliacea* (Hoffm.) Ach.

Thallus adnate; lobes sublinear to subirregular, the margins ciliate or bulbate-ciliate; lower surface black or brown, the rhizines simple or branched. Apothecia adnate, the exciple frequently coronate.

Section *Imbricaria* was first proposed by Schreber under the genus *Lichen* and characterized as follows: "Syn. *Squamaria* Hoffm. Frondes subfoliaceae, membranaceae, imbricatae, depressae, flexiles. Fr. scutellae." *Squamaria* is a genus set up by Hoffmann to accommodate the species now recognized as *Cetraria pinastri* (Scop.) Röhl. and *C. juniperina* (L.) Ach. Although Schreber cites only the Hoffmann name, we are not obliged to use it in typifying *Imbricaria*. It seems more appropriate to retain *Imbricaria* in the sense that it was so commonly used in the 19th century, that is, for the narrow lobed species of *Parmelia*. Acharius (1794) was the first to adopt Schreber's name and included under it species now classified in the genera *Physcia*, *Parmeliopsis*, *Xanthoria*, and *Parmelia*. Of these, *Parmelia tiliacea* is the most suitable choice as a lectotype for section *Imbricaria*.

Section *Imbricaria* may be divided into two subsections, *Imbricaria* and *Bicornutae* (p. 135), on the basis of whether marginal cilia or marginal bulbate cilia are present.

Subsection *Imbricaria*

Subsection *Myelochroa* Asah. (1952, p. 74).

Lectotype species: *Parmelia aurulenta* Tuck.

Thallus with simple marginal cilia, bulbate cilia lacking; lower surface usually black, the rhizines simple or sparsely branched or rarely squarrosely branched. Apothecia adnate, ecoronate.

In his study of the Japanese Parmelias, Asahina (1952) divided section *Hypotrachyna* Vain. into two subsections, *Myelochroa* (pigments present in the medulla) and *Myeloleuca* (medulla white). We have already reduced subsection *Myeloleuca* to synonymy under subsection *Parmelia*. The six pigmented species that Asahina included in subsection *Myelochroa* are all related to *P. aurulenta* Tuck. They all also have marginal cilia, a character that we consider to be of basic importance in classification. As far as we have been able to determine, medullary pigments have no value above the species level. Actually there are a number of pigmented species outside of Japan, unknown to Asahina at the time (e.g., *P. isidiocera* Nyl. and *P. silvatica* Lynge), which have branched rhizines and lack cilia and are classified below in section *Hypotrachyna*.

Subsection *Imbricaria* is a rather heterogeneous group of 33 species widely distributed in temperate and subtropical regions. The well-known species *P. dissecta* Nyl., *P. quercina* (Willd.) Vain., and *P. tiliacea* (Hoffm.) Ach. belong here. The distribution of chemical substances is very similar to subsection *Bicornutae* (cf. table 1) and the almost complete absence of sorediate species is similar. There seems to be no further natural subdivision of the subsection.

Key to Species in Subsection *Imbricaria*

1. Thallus isidiate or isidiate-lobulate.
 2. Isidia lobulate at maturity, dorsiventral.
 3. Medulla C+ rose (gyrophoric acid) . . . **2. P. spathulata** Kurokawa
 3. Medulla C-, KC+ rose (unknown) **P. horrescens** Tayl.
 2. Thallus isidiate, the isidia cylindrical.
 4. Medulla pigmented yellow orange, K-.
 5. Upper surface distinctly maculate **P. perisidians** Nyl.
 5. Upper surface not maculate.
 6. Thallus saxicolous; lobes sublinear, 1.0-1.5 mm. wide.

P. obsessa Ach.
 6. Thallus corticolous; lobes subrotund, 2-5 mm. wide.

P. lindmannii Lynge
 4. Medulla white.
 7. Medulla K+ yellow or red, C-.
 8. Medulla K+ persistent yellow; stictic acid present.

P. internexa Nyl.
 8. Medulla K+ yellow turning red.
 9. Norstictic acid present; tropical America . . . **P. antillensis** Nyl.
 9. Salacinic acid present; Old World.
 10. Lobes subrotund, the marginal cilia short.

P. wallichiana Tayl.
 10. Lobes sublinear, the marginal cilia often 1-3 mm. long.

P. usambarensis Stein. & Zahlbr.
 7. Medulla K-, C+ rose or red or C-.
 11. Medulla C- **P. ikomae** Asah.
 11. Medulla C+ rose or red.

12. Cortex strongly maculate; medulla C+ red (lecanoric acid).
P. tiliacea (Hoffm.) Ach.
12. Cortex weakly maculate or emaculate; medulla C+ rose (gyrophoric acid).
13. Lobes subrotund, 2-5 mm. wide.
1. P. melanochaeta Kurokawa
13. Lobes sublinear, 1-2 mm. wide **P. dissecta** Nyl.
1. Thallus lacking isidia or lobules.
14. Thallus pustulate; soredia scarcely if at all developed.
15. Medulla white **3. P. subfatiscens** Kurokawa
15. Medulla pale yellow or orange yellow.
16. Lobes 1-2 mm. wide; pustules fine, not sorediate; medulla C+ rose (gyrophoric acid) **P. spumosa** Asah.
16. Lobes 2-4 mm. wide; pustules coarsely sorediate; medulla C-.
P. aurulenta Tuck.
14. Thallus lacking pustules.
17. Thallus sorediate.
18. Medulla yellow orange **P. aurulenta** Tuck.
18. Medulla white.
19. Thallus yellowish green (usnic acid) **P. nylanderii** Lynge
19. Thallus mineral gray (usnic acid lacking).
20. Soredia subterminal; moniliform cells in the medulla.
P. metarevoluta Asah.
20. Soredia laminal; moniliform cells lacking . . . **P. muelleri** Vain.
17. Thallus lacking soredia.
21. Thallus pale brown below **P. versiformis** Krempfh.
21. Thallus jet black below.
22. Medulla white (even under the apothecia).
23. Medulla C+ blood red (lecanoric acid).
24. Lobes about 1 mm. wide **P. pruinata** Müll. Arg.
24. Lobes 2-5 mm. wide.
25. Thallus strongly maculate; apothecia with retrorse rhizines **P. carporrhizans** Tayl.
25. Thallus weakly maculate; retrorse rhizines lacking.
P. quercina (Willd.) Vain.
23. Medulla C-, P+ orange red.
26. Medulla K-, P+ (protocetraric acid).
P. michauxiana Zahlbr.
26. Medulla K+ red.
27. Thallus fragile, the cortex flaking off; spores 7-8 μ long; norstictic acid present **P. phlyctina** Hale
27. Thallus coriaceous, the cortex firm; spores 20-28 μ long; salacinic acid present **P. mutata** Vain.
22. Medulla yellow or yellow orange (especially under the apothecia).
28. Pigment K+ purple **P. denegans** Nyl.
28. Pigment K- or K+ more deeply yellow.
29. Lobes sublinear, 0.5-1.5 mm. wide.
30. Medulla P+ reddish (unknown); thallus firm.
P. galbina Ach.
30. Medulla P-; thallus fragile.
P. xantholepis Mont. & v.d. Bosch.
29. Lobes subrotund, 3-6 mm. wide.

31. Upper cortex without maculae; apothecia numerous; Mexico **P. immiscens** Nyl.
 31. Upper cortex more or less distinctly maculate; Asia.
 32. Cortex fragile, flaking off . . . **P. entotheiochroa** Hue
 32. Cortex continuous, firm.
 33. Spores 7–12 μ long **P. subaurulenta** Nyl.
 33. Spores 13–17 μ long **P. homogenes** Nyl.

1. *Parmelia melanochaeta* Kurokawa, sp. nov.

PLATE 3

Thallus laxe adnatus, olivaceo-albicans, 4–7 cm. latus, lobis irregularibus vel sublinearibus, subrotundatis, 2–6 mm. latis, margine crenatis, ciliatis, superne albomaculatus, isidiatus, subtus niger, rhizinosus, rhizinis nigris, simplicibus. Apothecia adnata vel substipitata, 1–3 mm. diametro; hymenium 80–90 μ altum; sporae 8–10 \times 13–15 μ .

Thallus loosely attached to bark, turning olive buff or cream buff (R) in the herbarium, 4–7 cm. in diameter; lobes irregularly branched, irregular to sublinear, 2–6 mm. wide, 110–150 μ thick, the margins crenate, ciliate, the cilia mostly simple, coarse, 1–2 mm. long (cf. pl. 1); upper surface shiny, rather distinctly white-maculate, moderately to densely isidiate, the isidia thin, cylindrical, often branched and with black spinules or short cilia; medulla white; undersurface black, dark brown in a rather wide zone near the tips, moderately rhizinate, the rhizines black to blackish brown, simple. Apothecia adnate to substipitate, 1–3 mm. in diameter, amphithecium isidiate, spinulate, disc vandyke brown (R); hymenium 80–90 μ high; spores 8–10 \times 13–15 μ .

Reactions: Thallus K+ yellow; medulla K–, C+ rose, KC+ red, P–, atranorine and gyrophoric acid present.

Type in the Naturhistoriska Riksmuseet, Stockholm, collected at Santa Anna da Chapada, Mato Grosso, Brazil, Jan. 18, 1894, by G. A. Malme (no. 2243; isotype in US).

This is an unusual species that could be mistaken for *P. dissecta* Nyl. In fact, Lynge identified the same material as *P. minarum* Vain., a synonym of *P. dissecta* (cf. Hale, 1960). Although the chemistry of the two species is identical, *P. melanochaeta* is much larger and loosely attached and has broad rotund lobes. It seems to be common in southern Brazil and adjacent Paraguay.

Additional specimens examined: Brazil: Buriti, Cerra da Chapada, Malme 2243, 2397B (S); Corumbá, Mato Grosso, Malme, August 1894 (S). Paraguay: Gran Chaco, Malme, Sept. 14, 1893 (S); Colonia Risso, Malme 1862 Aa*, 1862 Ba*, 1911 Ba (S).

2. *Parmelia spathulata* Kurokawa, sp. nov.

Thallus adnatus, corticola, olivaceo-albicans, 2–5 cm. diametro, lobis sublinearibus, plus minusve imbricatis, 1–3 mm. latis, margine dissectis, superne sparse ciliatis, nitidus, emaculatus, isidiato-lobulatus,

lobulis dorsiventralibus, apice dilatatis, subtus niger, rhizinosus, rhizinis nigris, sparse ramosis. Apothecia ignota.

Thallus adnate, growing over mosses on bark, pale glaucous green (R), 2–5 cm. in diameter; lobes irregularly branched, subimbricate, 1–3 mm. wide, 90–130 μ thick, the margins sparsely ciliate, dissected; upper surface shiny, without maculae, covered with numerous small isidioid lobules, the lobules dorsiventral, subascending, often branched and dilatated towards the apices; medulla white; undersurface black, rhizinate, the rhizines black, shiny, simple to sparsely branched. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K–, C+ rose, KC+ red, P–, atranorine and gyrophoric acid present.

Type in the Botanical Museum, Lund University, collected northwest of Tea-room, Skeleton Gorge, Wynberg, Cape Province, Union of South Africa, July 18, 1953, by Ove Alborn (no. 305; isotype in US).

This species is characterized by having numerous spathulate lobules and simple to sparsely branched rhizines. It is closely related to *P. dissecta* Nyl., which has similar chemistry but cylindrical isidia rather than lobules. *Parmelia spathulata* is apparently restricted to South Africa.

Additional specimens examined: Union of South Africa: Polela Forest, Polela, Natal, *Alborn* 9516 (LD, US); Kirstenbosch, Cape Province, *Arnell* 437 (LD).

3. *Parmelia subfaticens* Kurokawa, sp. nov.

Thallus adnatus, albido-cinerascens, 4–7 cm. latus, lobis sublinearibus, 0.5–1.5 mm. latis, margine ciliatis, superne planus, emaculatus, pustulatus, subtus niger, dense rhizinosus, rhizinis nigris, simplicibus. Apothecia adnata, 1.5–4.0 mm. diametro; hymenium 60–75 μ altum; sporae 8–9 \times 12–14 μ .

Thallus adnate on bark, pale olive gray to light mineral gray (R), 4–7 cm. in diameter; lobes dichotomously or irregularly branched, sublinear-elongate, 0.5–1.5 mm. wide, 80–100 μ thick, the margins crenate, ciliate, the cilia black, simple, 0.5–1.0 mm. long; upper surface plane and smooth, shiny, not maculate, pustulate, the pustules not becoming sorediate, often ciliate; medulla white; undersurface black, densely rhizinate, the rhizines black, simple, about 1.0 mm. long. Apothecia adnate, 1.5–4.0 mm. in diameter, margins smooth, disc clove brown (R), radially split; hymenium 60–75 μ high; spores 8–9 \times 12–14 μ .

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ rose, P–, atranorine and an unknown KC+ substance present.

Type in the Botanical Museum, Lund University, collected at Punch Bowl Inn, north of Louis Trichardt, Zoutpansberg, Transvaal,

Union of South Africa, Oct. 10, 1953, by Ove Almborn (no. 6443; isotype in US).

This species is very close to *P. dissecta* Nyl. but it is distinctly pustulate rather than isidiate and the medulla is C—, whereas *P. dissecta* is C+ rose (gyrophoric acid). The pustules are similar to those of *P. spumosa* Asah., a smaller species with a pale yellow medulla and gyrophoric acid. *Parmelia subfatiscens* has the same West Indies-Africa distribution characteristic of *P. exsplendens* Hale, *P. suffixa* Stirt., and *P. ventricosa* Hale & Kurokawa.

Additional specimens examined: Jamaica: Blue Mountains: North slope below Corn Puss, *Imshaug* 14550 (MSC); New Haven Gap, *Imshaug* 15137 (MSC, US). Union of South Africa: Natal: Boschfontein Forest, Lions River Distr., *Almborn* 8717 (LD); Transvaal: Forest Drive from Houtbosch to Tzaneen, Pietersburg, *Almborn* 6797 (LD); Cape Province: Deepwalls, Knysna, *Almborn* 3433 (LD).

Subsection *Bicornutae* (Lynge) Hale & Kurokawa, comb. nov.

Section *Bicornuta* Lynge (1913, p. 17). Type species: *P. semilunata* Lynge.

Subgenus *Bicornuta* (Lynge) Gyel. (1932, p. 219).

Thallus with marginal bulbate cilia; lower surface black or brown, the rhizines simple or branched. Apothecia frequently coronate.

Lynge first proposed section *Bicornuta* on the basis of two species, *P. semilunata* and *P. schiffneri* Zahlbr., both of which have peculiar bicornute spores. As a matter of fact, there is apparently only one other species in *Parmelia* with such spores, *P. bicornuta* Müll. Arg. However, these species also have marginal bulbate cilia, one of the most fundamental characters that we have found in subgenus *Parmelia*. Normally ciliate species (subsection *Imbricaria*) appear to be closely related in chemistry (see table 1).

This subsection of 46 primarily tropical species may be further subdivided into two series, based on the presence or absence of usnic acid, as follows:

Series *Bicornutae*

Thallus mineral gray; usnic acid lacking.

Series *Relicinae* Hale & Kurokawa, ser. nov.

Thallus stramineus vel viridiflavicans, acidum usnicum continens.

Type species: *Parmelia relicina* Fr.

When the bulbate-ciliate species are divided on the presence or absence of usnic acid, there is significant geographical correlation. In the series *Bicornutae* seven of the nine species with salacinic acid occur only in Africa. Of the nine C+ species, six are restricted to tropical America. Among the remaining species, five occur only in South America, two in Africa, one in America-Africa, and one

in Asia. In other words, the species in this series are most common in Africa and South America.

In the series *Relicinae* there are no species at all in Africa. Thirteen occur only in southeastern Asia and Australia, two in tropical America and the Pacific, two in tropical America only, and one in America-Asia. This series then shows very strong representation in southeastern Asia.

Key to Species in Subsection Bicornutae Series Bicornutae

1. Thallus isidiate or lobulate-isidiate.
 2. Lower surface pale brown.
 3. Medulla K+ red (salacinic acid).
 4. Thallus large, the lobes 2-5 mm. wide; upper surface not distinctly maculate **P. isidiza** Nyl.
 4. Thallus smaller, the lobes 1.0-2.5 mm. wide; upper surface distinctly maculate **P. subglandulifera** Hue
 3. Medulla K-, C+ rose (gyrophoric acid). **P. scortella** Nyl.
 2. Lower surface jet black.
 5. Isidia becoming dorsiventral, lobulate; medulla C+ rose (gyrophoric acid).
 6. Apothecia ecoronate. **P. suffixa** Stirt.
 6. Apothecia coronate. **P. fungicola** Lynge
 5. Isidia normal, cylindrical.
 7. Medulla K+ red.
 8. Norstictic acid present **6. P. ventricosa** Hale & Kurokawa
 8. Salacinic acid present.
 9. Plants saxicolous **4. P. decurtata** Kurokawa
 9. Plants corticolous **P. tabacina** Mont. & v. d. Bosch.
 7. Medulla K-.
 10. Medulla C-, KC+ red (unknown present).
 2. **P. apophysata** Hale & Kurokawa
 10. Medulla C+ rose or red.
 11. Medulla C+ deep red (lecanoric acid) . . . **P. laevigatula** Nyl.
 11. Medulla C+ rose (gyrophoric acid).
 12. Thallus tightly adnate, the lobes 0.5-1.0 mm. wide; Asia.
 2. **P. subdissecta** Nyl.
 12. Thallus loosely adnate, the lobes 1.0-3.0 mm. wide; tropical America **P. papyrina** Fée
1. Thallus without isidia.
 13. Lower surface pale brown.
 14. Apothecia coronate; norstictic acid present . **P. subcoronata** Müll. Arg.
 14. Apothecia ecoronate; salacinic acid present.
 15. Upper surface distinctly maculate **P. hypocraea** Vain.
 15. Upper surface dull, not maculate.
 16. Thallus small, the lobes 0.7-2.0 mm. wide; South America.
 2. **P. continua** Lynge
 16. Thallus medium sized, the lobes 2.0-5.0 mm. wide; Asia.
 2. **P. setschwanensis** Zahlbr.
 13. Lower surface jet black.
 17. Medulla K+ red (salacinic acid).

18. Upper surface coarsely pustulate, pustules breaking open, esorediate.
5. **P. pustulata** Hale
18. Upper surface smooth, pustules lacking.
19. Spores 7–9 μ long; Africa . . . **P. sensibilis** Stein. & Zahlbr.
19. Spores 14–19 μ long; eastern Asia . . . **P. meizospora** (Nyl.) Nyl.
17. Medulla K–.
20. Medulla C–.
21. Thallus adnate, the lobes 1–2 mm. wide.
22. Thallus coriaceous; bulbate cilia conspicuous; India.
3. **P. bulbochaeta** Hale
22. Thallus fragile; bulbate cilia small; South America.
P. viridescens Lynge
21. Thallus appressed, the lobes less than 1 mm. wide.
23. Lobes 0.3–1.0 mm. wide; spores elliptical.
1. **P. affixa** Hale & Kurokawa
23. Lobes 0.1–0.2 mm. wide; spores bicornute.
24. Spores 4–5 μ long **P. schiffneri** Zahlbr.
24. Spores 15–20 μ long **P. semilunata** Lynge
20. Medulla C+ rose or red.
25. Medulla C+ deep red (lecanoric acid).
26. Spores bicornute **P. bicornuta** Müll. Arg.
26. Spores elliptical **P. confoederata** Culb.
25. Medulla C+ rose (gyrophoric acid).
27. Apothecia coronate; upper cortex without maculae **P. coronata** Fée
27. Apothecia ecoronate; upper cortex distinctly maculate.
P. atrichella Nyl.

1. **Parmelia affixa** Hale & Kurokawa, stat. et nom. nov.

Parmelia coronata Fée var. *denudata* Vain. in Welw. Cat. Afr. Pl. 2, no. 2: 401.

1901. Type collection: Morro de Lopollo, Huilla, Angola, *Welwitsch* 33 (TUR, holotype; BM, isotype).

Thallus very closely adnate on bark, turning olive buff to tea green in the herbarium, about 3 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 0.3–1.0 mm. wide, 70–90 μ thick, the margins more or less crenate, with dense bulbate cilia; upper surface plane, shiny, emaculate, cracked on older lobes, isidia and soredia lacking; medulla white; undersurface black, densely rhizinate, rhizines black, shiny, simple. Apothecia numerous, adnate, 0.5–1.5 mm. in diameter, exciple smooth to crenate, coronate, the base retrorsely rhizinate; hymenium 40–50 μ high; spores 4–5 \times 8–10 μ , episporium 1 μ thick.

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ rose, P–, atranorine and a KC+ rose unknown substance (not further identified because of paucity of material).

The name *Parmelia denudata* has already been used by Hampe (Linnaea 17:121. 1843) for a species now recognized as *Everniopsis trulla* (Ach.) Nyl. *Parmelia affixa* is a small easily overlooked species that is probably more common than suspected in southwest Africa. It is one of the few coronate species in Africa.

Additional specimen examined: Africa: 10 km, north of Sá da Bandeira, Huila, Angola, *Degelius*, Mar. 2, 1960 (DEGEL, US).

2. *Parmelia apophysata* Hale & Kurokawa, sp. nov.

Thallus arcte adnatus, corticola, albido-olivascens, 3–6 cm. diametro, lobis sublinearibus, 0.7–1.5 mm. latis 90–130 μ crassis, margine bulbato-ciliatis, superne nitidus, isidiatus, isidiis cylindricis, subtus niger, rhizinosus, rhizinis dichotome ramosis. Apothecia ignota.

Thallus closely adnate on bark, turning light olive buff in the herbarium, 3–6 cm. in diameter; lobes sublinear-elongate, more or less dichotomously branched, 0.7–1.5 mm. wide, 90–130 μ thick, the margins densely bulbate-ciliate; upper surface plane, shiny, sometimes faintly maculate, often irregularly cracked on older lobes, sparsely to moderately isidiate, isidia simple, cylindrical, less than 0.3 mm. high; undersurface black, with a broad pale brown zone near the tips of lobes, short rhizinate, rhizines! pale to black, shiny, densely branched. Apothecia unknown.

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ reddish, P–, atranorine and an unknown KC+ substance (near alectoronic acid?) present.

Type in the U.S. National Herbarium, collected on mangrove tree in pine barrens, vicinity of Piedra Blanca, La Vega, Dominican Republic, Oct. 14, 1947, by H. A. Allard (no. 16073).

Parmelia apophysata is characterized by having a medium-sized thallus, simple cylindrical isidia, bulbate cilia and branched rhizines, and faintly maculate lobes. The unknown KC+ substance is noticeably fluorescent in ultraviolet light. This species resembles *P. subdissecta* Nyl., which has more adnate smaller lobes and a C+ pale-red reaction caused by gyrophoric acid. *Parmelia apophysata* is known only from the type collection but it is certain to be found in other collections from tropical America.

3. *Parmelia bulbochaeta* Hale, sp. nov.

PLATE 1

Thallus adnatus vel laxe adnatus, albido-cinerascens, coriaceus, 4–8 cm. diametro, lobis sublinearibus, 1.5–2.5 mm. latis, margine bulbato-ciliatis, superne planus, nitidus, emaculatus, isidiis sorediisque destitutus, subtus nigricans, dense rhizinosus, rhizinis nigricantibus, dichotome ramosis. Apothecia adnata, coronata, 2–3 mm. diametro; hymenium 40–50 μ altum; sporae 4 \times 5 μ .

Thallus adnate to loosely adnate, dark mineral gray, coriaceous, 4–8 cm. in diameter; lobes sublinear, 1.5–2.5 mm. wide, 160–210 μ thick, the margins entire, conspicuously bulbate-ciliate, bulbules with simple or branched apical cilia; upper surface plane, shiny, without maculae, usually heavily pycnidiate, soredia and isidia lacking; medulla white, dense; undersurface black, becoming brown at the

tips, densely rhizinate, rhizines black, brownish black near the margins, dichotomously branched. Apothecia adnate, 2–3 mm. in diameter, coronate; hymenium 40–50 μ high; spores $4 \times 5 \mu$.

Reactions: Thallus K+ yellow; medulla K–, C–, KC–, P–, only atranorine present.

Type in the herbarium of D. D. Awasthi, collected at Perumal coffee plantation, Shembaganur, Madurai district, India, elev. 5300–5700 ft., Dec. 23, 1959, by D. D. Awasthi (no. 4347; isotype in US).

Parmelia bulbochaeta resembles the South American species *P. coronata* Fée and *P. viridescens* Lynge in the presence of coronate apothecia, black undersurface, and branched rhizines, and in the absence of maculae. It differs in having a more robust coriaceous thallus and more conspicuous bulbate cilia and no chemicals other than atranorine. It is known only from two collections made in South India.

Additional specimen examined: College compound, Shembaganur, Madurai, India, *Awasthi* 4275 (AWAS).

4. *Parmelia decurtata* Kurokawa, sp. nov.

Thallus adnatus, saxicola, olivaceo-cinerascens, 3–7 cm. latus, lobis subirregularibus, subimbricatis, 1–3 mm. latis, margine crenatis, bulbato-ciliatis, superne planus, nitidus, emaculatus, isidiatus, subtus nigricans, rhizinosus, rhizinis nigris, simplicibus. Apothecia ignota.

Thallus closely adnate on rock, pale olive buff to pale olive gray (R), 3–7 cm. in diameter; lobes irregularly branched, subirregular to sublinear, more or less imbricate, 1–3 mm. wide, 220–300 μ thick, the margins crenate, moderately bulbate-ciliate; uppersurface plane, shiny, often cracked on older lobes, isidiate, the isidia cylindrical, often more or less granular, rarely branched; medulla white; undersurface dark brown to black, moderately to densely rhizinate, the rhizines black, simple, about 1 mm. long. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C–, KC–, P+ pale orange red, atranorine and salacinic acid present.

Type in the Botanical Museum, Lund University, collected 10 miles southeast of Lydenburg, Transvaal, Union of South Africa, Oct. 20, 1953, by Ove Almborn (no. 7388; isotype in US).

Parmelia decurtata bears a very close resemblance to *P. tabacina* Mont. & v.d. Bosch., a widespread corticolous species. They both have isidia, bulbate cilia, and salacinic acid. *Parmelia decurtata* differs in being strictly saxicolous, lacking any trace of maculae, and having smaller, often papillate, black-tipped isidia.

Additional specimens examined: Union of South Africa: Natal: Cathedral Peak Area, Bergville Distr., elev. 6000 ft., *Almborn* 9328

(LD); Cape Province: Bains Kloof, Wellington Distr., *Almborn* 5053 (LD).

5. *Parmelia pustulata* Hale, sp. nov.

Thallus adnatus, corticola, membranaceus, 6–10 cm. diametro, olivaceo-albicans, lobis subirregularibus, 4–6 mm. latis, apice subrotundatis, margine bulbato-ciliatis, superne planus vel rugosus, nitidus, isidiato-pustulatus, pustulis inflatis, subtus niger, modice rhizinosus, rhizinis simplicibus, ambitu castaneus, nudus vel papillatus. Apothecia ignota.

Thallus adnate on bark, membranaceous, 6–10 cm. in diameter, olivaceous to light mineral gray; lobes more or less subirregular, 4–6 mm. wide, the apices subrotund, the margins broadly crenate, inconspicuously bulbate-ciliate; upper surface plane to rugose, shiny, becoming moderately isidiate-pustulate, pustules inflated, irregular, breaking open apically, soredia absent; medulla white; lower surface black and moderately rhizinate at the center, the rhizines black, simple, the marginal zone bare or papillate, brown. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C–, KC–, P+ pale orange red, atranorine and salacinic acid present.

Type in the U.S. National Herbarium, collected in a bamboo forest, Urundi, Africa, elev. 2200 m., by Deuse (communicated by Dr. J. L. Ramaut, Liège, Belgium).

This species is unique in subsection *Bicornutae* in having large distinct pustules. Isidiate *P. tabacina* Mont. & v.d. Bosch. has similar lobe configuration and chemistry and is probably related to it. *Parmelia pustulata* is known only from the type collection.

6. *Parmelia ventricosa* Hale & Kurokawa, stat. et nom. nov.

Parmelia isidiza var. *domingensis* Vain. Ann. Acad. Sci. Fenn. 6, no. 7:17. 1915. Type collection: La Cumbra, Santo Domingo (Dominican Republic), *Raunkiaer* 492 (TUR, holotype; C, isotype).

Thallus adnate on bark, pale glaucous green, 3–5 cm. in diameter; lobes irregularly branched, 1–5 mm. wide, 65–80 μ thick; margins crenate, with bulbate cilia; upper surface plane and smooth, shiny, weakly maculate, more or less wrinkled on older lobes, isidiate, the isidia mostly simple, fine and short; medulla white; undersurface uniformly black, short-rhizinate, the rhizines black, simple. Apothecia adnate, coronate, more than 2.5 mm. in diameter, exciple crenate, amphithecium smooth, weakly maculate, disc russet, imperforate; hymenium 50–60 μ high; spores 7–8 \times 13–17 μ , the episporium 1.0–1.5 μ thick.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C–, KC–, P+ pale orange, atranorine and norstictic acid present.

The name *Parmelia domingensis* is preoccupied by *P. domingensis* Ach., which is now recognized as a species of *Anaptychia*. *Parmelia ventricosa* and *P. isidiza* Nyl. share isidia and bulbate cilia, but *P. ventricosa* has coronate apothecia and norstictic acid. *Parmelia isidiza*, a common African lichen, has ecoronate apothecia and salacinic acid. *Parmelia ventricosa* is a rather rare species in the Caribbean region with a disjunct locality in South Africa.

Additional specimens examined: Mexico: Chiapas: Near ranch, El Suspiro, *Hale* 20166 (US). Union of South Africa: Transvaal: Drive from Houtbosch to Tzaneen, Pietersburg, *Almborn* 6813 (LD).

Key to Species in Subsection Bicornutae Series Relicinae

1. Thallus isidiate or isidiate-lobulate.
 2. Isidia dorsiventral, lobulate.
 3. Medulla P+ red (unknown) 7. ***P. schizospatha*** Kurokawa
 3. Medulla P-, C+ rose (gyrophoric acid) 4. ***P. luteoviridis*** Kurokawa
 2. Isidia normal, cylindrical.
 4. Lower surface pale to dark brown.
 5. Upper surface maculate; rhizines simple.
 9. ***P. tumescens*** Hale & Kurokawa
 5. Upper surface emaculate; rhizines branched ***P. circumnodata*** Nyl.
 4. Lower surface jet black.
 6. Lobes more or less subirregular, to 3 mm. wide; medulla P+, K- (unknown) 5. ***P. planiuscula*** Kurokawa
 6. Lobes sublinear, 1-2 mm. wide; medulla P+, K+ red (norstictic acid).
 - P. abstrusa*** Vain.
1. Isidia and lobules lacking.
 7. Lower surface pale to dark brown.
 8. Base of apothecia retrorsely rhizinate; plants saxicolous; stictic acid present ***P. limbata*** Laur.
 8. Base of apothecia without retrorse rhizines; plants corticolous; stictic acid lacking.
 9. Rhizines black; protocetraric acid present.
 6. ***P. ramosissima*** Kurokawa
 9. Rhizines uniformly pale brown.
 10. Medulla K+ red (salacinic acid) 1. ***P. acrobotrys*** Kurokawa
 10. Medulla K- (protocetraric acid) 8. ***P. sublanea*** Kurokawa
 7. Lower surface jet black.
 11. Medulla P-, K-.
 12. Lobes appressed, 0.2-0.8 mm. wide ***P. relicinula*** Müll. Arg.
 12. Lobes adnate, 0.7-2.0 mm. wide.
 13. Rhizines mostly branched; protolichesteric acid present.
 2. ***P. connivens*** Kurokawa
 13. Rhizines mostly simple; fatty acids absent ***P. relicina*** Fr.
 11. Medulla P+, K+ red or K-.
 14. Medulla K+ red (norstictic acid) ***P. subabstrusa*** Gyel.
 14. Medulla K-.
 15. Apothecia ecoronate; P+ unknown present ***P. sublimbata*** Nyl.
 15. Apothecia coronate; fumarprotocetraric acid present.

16. Asci 16–32-spored **P. relicinella** Nyl.
 16. Asci 8-spored.
 17. Marginal bulbules ciliate, 0.3–1.0 mm. long; Pacific area.
P. samoensis Zahlbr.
 17. Marginal bulbules not ciliate, 0.1–0.2 mm. long; tropical
 America . . . **3. P. eximbricata** (Gyel.) Hale & Kurokawa

1. Parmelia acrobotrys Kurokawa, sp. nov.

PLATE 2

Thallus adnatus, viridi-flavicans, 6–12 cm. diametro, lobis sublinearibus, 1.0–2.5 mm. latis, margine bulbato-ciliatis, superne plerumque convexus, albomaculatus, isidiis sorediisque destitutus, subtus pallide castaneus, modice rhizinosus, rhizinis dense ramosis, pallidis. Apothecia substipitata, 1.0–3.5 mm. diametro; hymenium 50–60 μ altum; sporae 4–5 \times 7–8 μ .

Thallus adnate on bark, olive buff (R), 6–12 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 1.0–2.5 mm. wide, 240–320 μ thick, the margins smooth, with bulbate cilia; upper surface more or less convex, shiny, maculate, isidia and soredia lacking; medulla white; undersurface pinkish buff (R), moderately rhizinate, rhizines densely branched towards the tips, pale. Apothecia substipitate, without retrorse rhizines, 1.0–3.5 mm. in diameter, exciple crenate, amphithecium smooth, disc burnt amber (R); hymenium 50–60 μ high; spores 4–5 \times 7–8 μ .

Reactions: Thallus K+ yellowish; medulla K+ yellow turning red, C–, KC–, P+ pale orange red, atranorine, usnic acid, and salacinic acid.

Type in Herbarium Bogoriense, collected at Tjibodas, Java, May 1949, by Neervoort (no. 60 pr. p.; isotype in US).

Parmelia acrobotrys is closely related to *P. sublanea* Kurokawa. Both species have a pale undersurface, pale brown rhizines, ecoronate apothecia, and similar spores. *Parmelia acrobotrys* has coarser rhizines and contains salacinic acid, whereas *P. sublanea* contains protocetraric acid. The saxicolous species *P. limbata* Laur. is superficially similar but contains stictic acid. *Parmelia acrobotrys* is known only from the type collection.

2. Parmelia connivens Kurokawa, sp. nov.

PLATE 2

Thallus adnatus, viridiflavicans, 3–5 cm. diametro, lobis sublinearibus, 1.0–2.5 mm. latis, margine bulbato-ciliatis, superne planus vel convexus, sorediis et isidiis destitutus, subtus niger, dense rhizinosus, rhizinis nigris, ramosis. Apothecia adnata, 1.0–2.5 mm. diametro, retrorso-rhizinata; hymenium 45–60 μ altum; sporae 2–3 \times 4–6 μ .

Thallus adnate, deep sea-foam green (R), turning cinnamon buff (R) in the herbarium, 3–5 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 1.0–2.5 mm. wide, 120–160 μ thick, the

older lobes becoming lobulate, the margins smooth, narrowly black-rimmed near the tips, with bulbate cilia; upper surface plane to slightly convex, smooth but becoming rugulose and cracked on older lobes, soredia and isidia lacking; undersurface almost uniformly black, densely rhizinate, the rhizines black, irregularly branched, sometimes projecting beyond the margins. Apothecia adnate, 1.0–2.5 mm. in diameter, retrorsely rhizinate, exciple crenate, disc seal brown (R); hymenium 45–60 μ high; spores 2–3 \times 4–6 μ .

Reactions: Thallus K+ yellowish; medulla K–, C–, KC–, P–, atranorine, usnic acid, and protolichestic acid present.

Type in the Kew Herbarium, collected in the Milne Bay district, Papua, New Guinea, Sept. 11, 1954, by R. D. Hoogland (no. 4726; isotypes in L, US).

At first glance this species resembles *P. acrobotrys* Kurokawa and *P. ramosissima* Kurokawa but it is easily distinguished by the black undersurface and the negative reaction with P. No other species in series *Relicinae* produces a fatty acid. It is a typical Indonesian species.

Additional specimens examined: Molucca Islands: Tanimbar Island, P. Jamdena, *Buwalda* 4246 (BO). Guam: *McGregor* s.n. (H).

3. *Parmelia eximbricata* (Gyel.) Hale & Kurokawa, comb. nov.

Parmelia samoensis Zahlbr. var. *eximbricata* Gyel. Ann. Mycol. 36:288. 1938. Type collection: Monte Rus, Cuba, *Hioram* 10506 (BP, holotype).

Thallus closely adnate on bark, massicot yellow (R), 3–5 cm. in diameter; lobes more or less dichotomously branched, sublinear, 0.7–1.5 mm. wide, 160–200 μ thick; margins crenate, with small bulbate cilia, 0.1–0.2 mm. long; upper surface plane, smooth and shiny emaculate, isidia and soredia lacking; medulla white; under-surface black, densely rhizinate, the rhizines black, simple. Apothecia common, adnate, 0.5–1.5 mm. in diameter, exciple coronate, the base of the amphithecium often retrorsely rhizinate; hymenium 45–55 μ high; spores 4–5 \times 7–9 μ , the episporium 1 μ thick.

Reactions: Thallus K–; medulla K–, C–, KC–, P+ brick red, fumarprotocetraric acid and usnic acid present.

Parmelia eximbricata resembles the Pacific species *P. samoensis* Zahlbr. in having coronate apothecia and fumarprotocetraric acid. The marginal bulbate cilia of *P. samoensis* however are longer and more conspicuous, and tipped with distinct cilia. This species is widely distributed in the Caribbean as far north as southern Florida, usually occurring at low elevations.

Additional specimens examined: Florida: Big Pine Key, Florida Keys, *Swanson & Dowling* C-795 (US). Jamaica: Wareika House, summit of Long Mountain, St. Andrew *Imshaug* 13492 (MSC); north

slope of Montpelier, St. Catherine, *Imshaug* 14261 (MSC, US). Grand Cayman: Near Georgetown, *Imshaug* 24385 (MSC); center of Island, *Imshaug* 24518 (MSC, US). Dominican Republic: Vicinity of Ciudad Trujillo, Santo Domingo, *Allard* 16186, 16192 (US); near Río Chavón, east of La Romana, La Altagracia, *Hassler*, July 31, 1935 (WISC). Cuba: Without locality, *Wright*, *Lich. Cub. ser. II*, 10 (US).

4. *Parmelia luteoviridis* Kurokawa, sp. nov.

PLATE 2

Thallus adnatus, corticola, viridiflavicans, ca. 7 cm. diametro, lobis sublinearibus, 1.5–3.0 mm. latis, margine dense lobulatis, bulbato-ciliatis, superne nitidus, lobulatus, lobulis vulgo ramosis, subtus niger, rhizinosus, rhizinis nigris, sparse ramosis. Apothecia ignota.

Thallus adnate on bark, deep sea-foam green to light dull green yellow (R), about 7 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 1.5–3.0 mm. wide, 160–200 μ thick, the margins lobulate, with shiny bulbate cilia; upper surface plane and smooth, shiny, faintly maculate, lobulate, the lobules dorsiventral, not ascending, often dichotomously branched, rhizinate below; undersurface black, rhizinate, the rhizines black, shiny, sparsely branched. Apothecia not seen.

Reactions: Thallus K+ yellowish; medulla K–, C+ rose, KC+ red, P–, atranorine, usnic acid, and gyrophoric acid.

Type in the Herbarium Bogoriense, collected on peak of B. Papan, Beu territory, E. Kutai, Borneo, July 8, 1952, by W. Meijer (no. B1948; isotype in US).

This species is characterized by the conspicuous yellow richly lobulate thallus and by the production of gyrophoric acid. It is the only species in series *Relicinae* with a C+ substance. It resembles *P. schizospatha* Kurokawa in having lobules and a black lower surface but has wider lobes and greater development of lobules. *Parmelia schizospatha* is C–, P+ red. *Parmelia luteoviridis* is still known only from the type locality.

Additional specimen examined: Borneo: Same data as the holotype, *Meijer* B1548a (B0).

5. *Parmelia planiuscula* Kurokawa, sp. nov.

Thallus adnatus, corticola, viridiflavicans, usque ad 9 cm. latus, lobis sublinearibus, 1–3 mm. latis, margine subcrenatis, bulbato-ciliatis, superne planus, nitidus, sparse isidiatus, subtus niger, modice rhizinosus, rhizinis nigris, simplicibus. Apothecia ignota.

Thallus adnate to loosely attached over mosses on bark, rather rigid, turning deep olive buff (R) in the herbarium, about 9 cm. in diameter; lobes irregularly branched, sublinear-elongate, 1–3 mm.

wide, 150–190 μ thick, the margins more or less crenate, with bulbate cilia; upper surface plane and smooth, shiny, faintly maculate, sparsely isidiate, isidia simple, cylindrical, less than 0.7 mm. high; medulla white; undersurface black, moderately rhizinate, the rhizines black, shiny, simple. Apothecia not seen.

Reactions: Thallus K+ yellowish; medulla K–, C–, KC–, P+ orange red, atranorine, usnic acid, and an unknown P+ substance.

Type in the Herbarium Bogoriense, collected at Kandang Badak, Java, May 27, 1949, by Neervoort (no. 427; isotype in US).

Externally this species resembles *P. tumescens* Hale & Kurokawa. It differs in having a black undersurface and a P+ unknown substance instead of stictic acid. *Parmelia circumnodata* Nyl., a much smaller lichen, has short sparse isidia, a pale undersurface with branched rhizines, and protocetraric acid. *Parmelia abstrusa* Vain., the fourth isidiate species in series *Relicinae*, has a thick rigid thallus and produces norstictic acid. *Parmelia planiuscula* is still known only from the type locality.

6. *Parmelia ramosissima* Kurokawa, sp. nov.

PLATE 2

Thallus adnatus, corticola, obscure viridiflavicans, ca. 3 cm. diametro, lobis sublinearibus, 0.7–2.0 mm. latis, margine integris, bulbato-ciliatis, superne nitidus, albomaculatus, isidiis sorediisque destitutus, subtus pallide castaneus, rhizinosus, rhizinis nigricans, dense ramosis. Apothecia adnata, ecoronata, retrorso-rhizinata; hymenium 40–50 μ altum; sporae $2 \times 3 \mu$.

Thallus adnate on bark, turning dark olive buff (R) in the herbarium, more than 3 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 0.7–2.0 mm. wide, 200–240 μ thick, the margins smooth, with bulbate cilia; upper surface plane and smooth, rather shiny, maculate, isidia and soredia lacking; medulla white; undersurface pale brown to brown, moderately rhizinate, the rhizines blackening, finely and densely branched. Apothecia adnate, ecoronate, 1.0–2.5 mm. in diameter, exciple crenate, often basally retrorsely rhizinate, disc warm blackish brown (R); hymenium 40–50 μ high; spores about $2 \times 3 \mu$.

Reactions: Thallus K+ yellowish; medulla K–, C–, KC+ reddish, P+ orange red, usnic acid and protocetraric acid present.

Type in Herbarium Bogoriense, collected on Tanimbar Island, Moluccas, Apr. 2, 1938, by P. Buwalda (no. 4583; isotype in US).

This species resembles *P. acrobotrys* Kurokawa in habit and in the pale undersurface. However, *P. ramosissima* is distinctly maculate and contains protocetraric rather than salacinic acid. It has the smallest spores of any species in section *Relicinae*. It is presently known only from the type locality.

7. *Parmelia schizospatha* Kurokawa, sp. nov.

PLATE 2

Thallus adnatus, corticola, obscure viridiflavicans, ca. 5 cm. diametro, lobis sublinearibus, 1–2 mm. latis, margine subcrenatis, bulbato-ciliatis, lobulatis, lobulis ramosis, superne planus, nitidulus, lobulatus, subtus niger, modice rhizinosus, rhizinis nigris, simplicibus. Apothecia ignota.

Thallus adnate on bark, turning deep olive buff (R) in the herbarium, about 5 cm. in diameter; lobes irregularly branched, sublinear-elongate, 1–2 mm. wide, 100–120 μ thick, the margins more or less crenate, with black bulbate cilia, lobulate, the lobules dorsiventral, often dichotomously branched, not ascending; upper surface plane and smooth, faintly maculate, somewhat shiny, lobulate, the lobules the same as the marginal ones; undersurface black, moderately rhizinate, the rhizines black, shiny, simple. Apothecia not seen.

Reactions: Thallus K+ yellowish; medulla K–, C–, KC–, P+ orange red, usnic acid and an unknown P+ substance present.

Type in Herbarium Bogoriense, collected at Gegerbentang, Java, June 27, 1949, by Neervoort (no. 1062; isotype in US).

This new species is identical with *P. sublimbata* Nyl. in chemistry but it is distinctly lobulate. The lobules are quite fragile and frequently branched. At present the species is known only from the type locality.

8. *Parmelia sublanea* Kurokawa, sp. nov.

Thallus adnatus, rigidulus, obscure viridiflavicans, ca. 10 cm. diametro, lobis sublinearibus, subimbricatis, 1–2 mm. latis, margine integris, bulbato-ciliatis, ciliis apice ramosis, superne planus vel convexus, nitidus, emaculatus, isidiis sorediisque destitutus, subtus pallide castaneus, dense rhizinosus, rhizinis pallide castaneis, dense ramosis. Apothecia substipitata, 1.0–4.5 mm. diametro; hymenium 40–50 μ altum; sporae 4–5 \times 7–9 μ .

Thallus rather rigid, olive buff to deep olive buff (R), corticolous, about 10 cm. in diameter; lobes dichotomously branched, sublinear-elongate, subimbricate, 1–2 mm. wide, 220–300 μ thick, the margins entire, often brown rimmed, with bulbate cilia; upper surface plane to more or less convex, smooth and shiny, without maculae, isidia and soredia lacking; medulla white; undersurface pale brown, densely rhizinate, the rhizines pale brown, densely branched, often forming a woolly mat. Apothecia substipitate, 1.0–4.5 mm. in diameter, exciple crenate, more or less undulate, amphithecium smooth, disc seal brown (R); hymenium 40–50 μ high; spores 4–5 \times 7–9 μ .

Reactions: Thallus K+ yellowish; medulla K–, C–, KC+ reddish, P+ orange red, usnic acid and protocetraric acid present.

Type in Herbarium Bogoriense, collected on route between Ake

Biaur and Tolewang, Halmahera Island, Oct. 12, 1951, by P. Groenhardt (no. 8409; isotype in US).

As previously discussed, *P. sublanea* is very similar to *P. acrobotrys* except in chemistry. *Parmelia ramosissima* has similar chemistry but the rhizines are darker. The bulbate cilia of *P. sublanea* are unusual in being almost spherical and quite large. The species is known only from the type locality.

9. *Parmelia tumescens* Hale & Kurokawa, stat. et nom. nov.

Parmelia limbata Laur. f. *isidiosa* Müll. Arg. Flora 70:59. 1887. Type collection: Richmond River, Australia, *Hodgkinson* s.n. (G, holotype).

Thallus adnate on bark, turning deep olive buff in the herbarium about 4 cm. in diameter; lobes dichotomously branched, sublinear, 1.0–1.5 mm. wide, 190–230 μ thick, the margins subcrenate, with bulbate cilia; upper surface more or less convex, irregularly cracked on older lobes, white-maculate, isidiate, the isidia cylindrical, simple or branched, up to 0.5 mm. high; medulla white; undersurface brown, moderately rhizinate, the rhizines simple, rather thick, dark brown to black. Apothecia not seen.

Reactions: Thallus K—; medulla K+ yellow, C—, KC—, P+ pale orange red, usnic acid and stictic acid present.

The specific epithet *isidiosa* is preempted by *Parmelia isidiosa* (Müll. Arg.) Hale, a species in subgenus *Xanthoparmelia*. Except for the presence of isidia, *P. tumescens* is very similar to *P. limbata* Laur., another Australian species that occurs commonly on rocks rather than bark.

Additional specimens examined: Australia: Eastern Creek, New South Wales, *Wilson* (H); Brisbane, Queensland, *Bailey* (BM).

4. Section *Cyclocheila* (Vain.) Räs. (1943, p. 10)

Section *Hypotrachyna* **Cyclocheila* Vain. (1890, p. 47).

Pseudoparmelia Lynge (1913, p. 15). Type species: *P. cyphellata* (Lynge) Sant.

Section *Subflavescentes* (Vain.) Gyel. subsection *Eciliatae* Gyel. (1932, p. 225). Lectotype: *P. caperata* (L.) Ach.

Section *Hypotrachyna* subsection *Cyclocheila* (Vain.) Gyel. (1932, p. 224).

Section *Hypotrachyna* subsection *Cyclocheila* (Vain.) Hillm. (1934, p. 187). Superfluous combination.

Section *Pseudoparmelia* (Lynge) Räs. (1943, p. 10).

Lectotype species: *Parmelia amazonica* Nyl.

Thallus adnate to loosely attached; lobes sublinear and truncate to subirregular and subrotund; lower surface black or brown, the rhizines simple, often coarse.

As we previously mentioned (p. 129), Vainio first recognized *Cyclocheila* as a group under section *Hypotrachyna*, characterized by

subrotund lobes and including three species, *P. amazonica* Nyl., *P. minarum* Vain. (= *P. dissecta* Nyl.), and *P. muelleri* Vain. The latter two species are ciliate and should be classified in our section *Imbricaria* subsection *Imbricaria*. Vainio (1923) later combined this group and *Irregulares* into a single section *Irregulares* (Vain.) Vain. We have amended section *Irregulares* to include only species with a reticulate upper cortex, marginal cilia, and usually squarrosely branched rhizines.

The type species of section *Cyclocheila*, *Parmelia amazonica*, has simple unbranched rhizines and lacks any marginal cilia. There are 45 additional eciliate species with simple rhizines that can be classified here. These include typical sublinear-lobed species (e. g., *P. sphaerospora* Nyl., *P. texana* Tuck.) and a number of subirregular, subrotund-lobed species, such as *P. amazonica* Nyl., *P. caperata* (L.) Ach., *P. caroliniana* Nyl., and *P. soledians* Nyl. Some of these species have a narrow bare or papillate zone below at the margins and could be confused with species in subgenus *Amphigymnia*. Section *Cyclocheila* is best represented in Africa where 18 of the species are endemic; they are often saxicolous. Divaricatic acid is especially common along with a number of other K—, P— acids also found in section *Hypotrachyna* (see below, also cf. table 1).

Lynge first proposed the genus *Pseudoparmelia* on the supposed discovery of "pseudocyphellae" on the lower surface of *Parmelia cyphellata*, a mistake followed by Räsänen (1943). Santesson (1944) has conclusively shown that these structures are merely breaks or gashes in the lower cortex where rhizines have been torn away. Gyelnik (1933) used this genus name to accommodate the pseudocyphellate *Amphigymnia* species related to *Parmelia cetrarioides* (Duby) Nyl., but this application of the name seems to be incorrect.

In his original publication, Räsänen (1943) did not actually indicate himself as the author of section *Cyclocheila* but listed Vainio alone, apparently on the mistaken assumption that Vainio had recognized this taxon at the sectional level previously. Räsänen clearly cites *Cyclocheila* as a section, however, and we believe he should be cited as the author of the new combination.

Key to Species in Section *Cyclocheila*

1. Thallus isidiate or pustulate.
 2. Thallus distinctly pustulate; soredia absent or only sparsely developed.
 3. Thallus corticolous; lobes rather broad, 2–5 mm. wide.
 4. Medulla P— (divaricatic acid) 4. **P. eruptens** Kurokawa
 4. Medulla P+ red (protocetraric acid) **P. raunkiaeri** Vain.
 3. Thallus saxicolous; lobes narrow, to 1 mm. wide.
 5. Medulla P+ red (unknown) 6. **P. imperfecta** Kurokawa
 5. Medulla P—.

6. Caperatic acid present 8. **P. pustulescens** Kurokawa
 6. Divaricatic acid present **P. owariensis** Asah.
2. Thallus with cylindrical isidia.
7. Lower surface pale brown.
8. Medulla pale yellow **P. cyphellata** (Lynge) Sant.
8. Medulla white.
9. Lobes broad, 2–5 mm. wide; subrotund . . . 9. **P. salacinifera** Hale
9. Lobes narrow, 0.5–2.0 mm. wide, sublinear.
10. Thallus mineral gray, usnic acid lacking . 2. **P. arcana** Kurokawa
10. Thallus yellowish green (usnic acid).
11. Lobes 1.5–2.0 mm. wide; rhizines black.
P. abstrusoides des Abb.
11. Lobes 0.5–1.5 mm. wide; rhizines mostly pale.
12. Medulla P–, KC+ orange (barbatic acid).
P. rahengensis Vain.
12. Medulla P+ red (protocetraric acid) . . **P. malaccensis** Nyl.
7. Lower surface jet black.
13. Thallus yellowish green (usnic acid) **P. ecaperata** Müll. Arg.
13. Thallus mineral gray (usnic acid lacking).
14. Thallus saxicolous.
15. Medulla C+ deep red (lecanoric acid) . 1. **P. annexa** Kurokawa
15. Medulla C–, P+ pale orange (stictic acid).
7. **P. ischnoides** Kurokawa
14. Thallus corticolous.
16. Medulla P+ orange red.
17. Medulla K+ red (salacinic acid) **P. cinerascens** Lynge
17. Medulla K– or brownish (protocetraric acid).
18. Isidia rather irregular, often becoming granular.
P. martinicana Nyl.
18. Isidia cylindrical, normal **P. amazonica** Nyl.
16. Medulla P–.
19. Upper cortex finely cracked; perlatolic acid present.
P. caroliniana Nyl.
19. Upper cortex continuous or irregularly cracked with age.
20. Lobes subrotund, 2–5 mm. wide; KC+red unknown present.
P. meiosperma (Hue) Dodge
20. Lobes sublinear, 1.5–2.0 mm. wide; divaricatic acid present.
P. concrescens Vain.
1. Thallus lacking pustules or isidia.
21. Thallus sorediate.
22. Thallus yellowish green (usnic acid).
23. Medulla K+red (salacinic acid); soredia farinose . **P. soredians** Nyl.
23. Medulla K– (protocetraric acid); soredia coarse, originating from
 pustules **P. caperata** (L.) Ach.
22. Thallus mineral gray (usnic acid lacking).
24. Upper cortex reticulately ridged and wrinkled; stictic acid present.
25. Lobes subrotund, 2–5 mm. wide **P. crozalsiana** B. de Lesd.
25. Lobes sublinear, 1.0–2.5 mm. wide . . **P. carneopruinata** Zahlbr.
24. Upper cortex plane, not ridged.
26. Soredia strongly capitate, submarginal.
P. cryptochlorophaea Hale
26. Soredia laminal, not strongly capitate.

27. Yellowish pigment present under soralia; KC+ unknown present **P. aptata** Krempfh.
27. Pigments absent; divaricatic acid present . . . **P. texana** Tuck.
21. Thallus lacking soredia.
28. Lower surface pale to dark brown.
29. Medulla pigmented, the pigment K+ purple black.
30. Pigment present throughout the medulla. **11. P. violacea** Kurokawa
30. Pigment present only in lower half of the medulla. **P. hypomilta** Fée
29. Medulla white or pale yellow, the pigment K—.
31. Medulla pale yellow.
32. Thallus saxicolous; lobes 1 mm. wide or less. **P. chapadensis** Lynge
32. Thallus corticolous; lobes 2–5 mm. wide . **P. sphaerospora** Nyl.
31. Medulla white, without any pigments.
33. Thallus corticolous; medulla P+ orange red (protocetraric acid).
34. Usnic acid present **P. intertexta** Mont. & v.d. Bosch.
34. Usnic acid absent.
35. Spores 5–7×8–11 μ ; Africa . . . **P. somaliensis** Müll. Arg.
35. Spores 14–18×26–28 μ ; South America. **P. leucopis** Krempfh.
33. Thallus saxicolous; medulla P—.
36. Medulla C+ deep red (lecanoric acid) . . **P. molybdiza** Nyl.
36. Medulla C— **10. P. tortula** Kurokawa
28. Lower surface jet black.
37. Medulla pigmented, the pigment K+ purple black.
38. Thallus yellowish green (usnic acid) . . **P. rutidota** Hook. & Tayl.
38. Thallus mineral gray (usnic acid lacking).
39. Thallus saxicolous, the lobes subareolate, appressed. **P. lecanoracea** Müll. Arg.
39. Thallus corticolous, the lobes loosely adnate. **5. P. heterochroa** Hale & Kurokawa
37. Medulla white; pigments absent.—
40. Thallus saxicolous.
41. Lobes appressed to the substratum.
42. Medulla C+ red (lecanoric acid) **P. molybdiza** Nyl.
42. Medulla C—.
43. Medulla K+ yellow (stictic acid). **P. xanthomelaena** Müll. Arg.
43. Medulla K— (divaricatic acid) **P. rupicola** Lynge
41. Lobes loosely adnate.
44. Medulla P+ red (protocetraric acid) . . . **3. P. caribaea** Hale
44. Medulla P— (divaricatic acid) **P. rodriguesiana** Hue
40. Thallus corticolous.
45. Thallus yellowish green (usnic acid) . **P. rutidota** Hook. & Tayl.
45. Thallus mineral gray (usnic acid lacking).
46. Medulla K+ yellow (stictic acid); upper cortex reticulately ridged **P. scrobicularis** Krempfh.
46. Medulla K—; upper cortex plane **P. subtiliacea** Nyl.

1. *Parmelia annexa* Kurokawa, sp. nov.

PLATE 4

Thallus arcte adnatus, saxicola, albido-cinereascens, 3–7 cm. latus, lobis sublinearibus, centrum versus subimbricatis, 0.7–3.5 mm. latis, margine crenatis, superne nitidus, emaculatus, isidiatus, subtus niger sparse rhizinosus, rhizinis nigris, simplicibus. Apothecia adnata, 1.5–5.0 mm. diametro; hymenium 70–80 μ altum; sporae 5 \times 7–8 μ .

Thallus tightly adnate on rock, pale olive gray to light mineral gray (R), 3–7 cm. in diameter; lobes irregularly branched, sublinear-elongate, more or less imbricate towards the center, 0.7–3.5 mm. wide, 180–240 μ thick, the margins crenate; upper surface plane, shiny, not maculate, irregularly cracked with age, isidiate, the isidia cylindrical, mostly simple, darkening at the tips, about 0.2 mm. high; medulla white; undersurface black, sparsely rhizinate, the rhizines black, simple. Apothecia adnate, 1.5–5.0 mm. in diameter, exciple undulate, amphithecium isidiate, disc snuff brown (R); hymenium 70–80 μ high; spores 5 \times 7–8 μ .

Reactions: Thallus K+ yellow; medulla K–, C+ deep red, KC+ red, P–, atranorine and lecanoric acid present.

Type in the Botanical Museum, Lund University, collected at Mossel River, 3 miles east of Hermanus, Caledon, Cape Province, Union of South Africa, Sept. 29, 1953, by Ove Alborn (no. 5683; isotype in US).

This is a typical South African saxicolous lichen clearly related to *P. molybdiza* Nyl., the only other species of the section *Cyclocheila* with lecanoric acid. *Parmelia molybdiza* differs in lacking isidia and in having a pale brown, rarely black, undersurface. Both species grow tightly adnate on exposed acidic rocks over a wide area in southern Africa.

Additional specimens examined: Angola: Malanje: Between Benguela and Coporolo, *Degelius*, Feb. 2, 1960 (DEGEL), Duque de Braganca, *Degelius*, Mar. 5, 1960 (DEGEL, US). Union of South Africa: Natal: 8 miles south of Lomkile, Nongoma Distr., *Höeg*, August 1929 (TRH); Cape Province: Cape Town, *Höeg*, May 31, 1929 (TRH). Mossel River, Caledon Distr., *Alborn* 5701 (LD), Camps Bay, Cape Distr., *Alborn* 4402 (LD).

2. *Parmelia arcana* Kurokawa, sp. nov.

PLATE 4

Thallus arcte adnatus, saxicola, albido-cinereascens, 3–7 cm. latus, lobis sublinearibus, 0.3–1.0 mm. latis, margine subcrenatis, superne nitidus, emaculatus, isidiatus, medulla pro parte pallide flavescens, subtus castaneus, sparse rhizinosus, rhizinis castaneis, simplicibus. Apothecia ignota.

Thallus tightly adnate on rock, pale to dark olive gray (R), 3–7 cm. in diameter; lobes dichotomously or irregularly branched, sublinear-

elongate, areolate toward the center, 0.3–1.0 mm. wide, 100–150 μ thick, the margins more or less crenate; upper surface plane to convex rather shiny, not maculate, tangentially cracked on older lobes isidiate, the isidia cylindrical, mostly simple, about 0.2 mm. high; medulla white, partly pale yellow in the upper half; undersurface brown to pale brown, sparsely rhizinate, the rhizines brown, simple. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K–, C–, KC–, P–, pigment if present K–, atranorine, an unidentified fatty acid, and an unidentified pale yellow pigment present.

Type in the herbarium of G. Degelius, collected in desert northeast of Baba, Mocâmedes, Angola, Feb. 5, 1960, by G. Degelius (isotype in US).

Parmelia arcana is a tightly adnate saxicolous species with the same habit and lobe configuration as *P. annexa* Kurokawa and *P. molybdiza* Nyl. These latter two species contain lecanoric acid. The pale undersurface of *P. molybdiza* is reminiscent of *P. arcana*, and the isidia of *P. annexa* are similar to those of *P. arcana* except that they are generally more papillate.

Additional specimen examined: Union of South Africa: Koningskroon, Elliott Distr., Cape Prov., Höeg, Dec. 1, 1929 (TRH).

3. *Parmelia caribaea* Hale, sp. nov.

PLATE 3

Thallus adnatus, eborinus vel cinereo-albicans, saxicola, 6–10 cm. diametro, lobis parum lobatis, irregulariter sublinearibus, subimbricatis, margine integris, superne planus, demum rugosus, sorediis isidiisque destitutus, subtus niger, modice rhizinosus, rhizinis crassis, nigris, simplicibus, ambitu fusco-castaneus, anguste nudus vel papillatus. Apothecia subpedicellata, urceolata, usque ad 5 mm. diametro; hymenium 50–60 μ altum; sporae 4–5 \times 10–13 μ .

Thallus adnate, saxicolous, ivory to whitish gray, 6–10 cm. wide, rather coriaceous; lobes irregularly sublinear, infrequently branched, more or less imbricate, 3–6 mm. wide, 200–250 μ , the margins entire to undulate, more or less black-rimmed, soredia and isidia lacking; upper surface plane, rugulose with age, cracked on older lobes; medulla white; undersurface black, moderately rhizinate, the rhizines thick, simple, the marginal zone brown, narrowly naked or papillate. Apothecia subpedicellate, at first globose, urceolate at maturity, up to 5 mm. in diameter, amphithecium rugose, the disc imperforate; hymenium 50–60 μ high; spores 4–5 \times 10–13 μ .

Reactions: Thallus K+ yellow; medulla K–, KC+ rose, C–, P+ orange red, atranorine and protocetraric acid present.

Type in the Missouri Botanical Garden, collected at Flanc Nord, Morne de Villet, St. Barthelemy, West Indies, Oct. 23, 1952, by C. Le Gallo (no. 494; isotype in US).

This remarkable species has been collected only on the island of St. Barthelemy. It is a saxicolous lichen without any obvious affinities. The mode of branching and the undersurface resemble *P. nairobiensis* Stein. & Zahlbr. and related South African species that contain divaricatic acid. *Parmelia caribaea* also has the black-rimmed margins typical of these species but the upper surface lacks any distinct white-netted reticulation. The apothecia are peculiar in that the disc may remain closed until quite late in the development of apothecia, so that young apothecia appear like spherical buds.

Additional specimens examined: St. Barthelemy: Saline, *Le Gallo* 491 (MO, US); Morne de Villet, *Le Gallo* 473 (MO, US); without specific locality, *Le Gallo* 2604 (MSC).

4. *Parmelia eruptens* Kurokawa, sp. nov.

PLATE 3

Thallus adnatus, corticola, olivaceo-albicans, 5–8 cm. diametro, lobis subirregularibus, 2–8 mm. latis, margine crenatis, superne emaculatus, isidiatus, isidiis crassis, inflatis, apice demum pustulescentibus, subtus niger, sparse rhizinosus, ambitu castaneus, subnudus, rhizinis nigricans, simplicibus. Apothecia adnata, 1–3 mm. diametro; hymenium 90–100 μ altum; sporae 5–7 \times 10–12 μ .

Thallus adnate on bark, marguerite yellow to olive buff (R), 5–8 cm. in diameter; lobes irregularly branched, subrotund, 2–8 mm. wide, 190–240 μ thick, the margins crenate, dark brown-rimmed near the tips; upper surface smooth and shiny, without maculae, moderately to densely isidiate, the isidia irregularly inflated, narrower at the base, at length breaking open at the tips; medulla white; undersurface black, brown and naked in a narrow zone near the tips, sparsely rhizinate, the rhizines pale near the margins, blackening at the center, simple. Apothecia adnate, 1–3 mm. in diameter, exciple more or less crenate, amphithecium isidiate, disc vandyke brown (R); hymenium 90–100 μ high; spores 5–7 \times 10–12 μ .

Reactions: Thallus K+ yellow; medulla K–, C–, KC– or KC + fleeting purple violet, P–, atranorine and divaricatic acid present.

Type in the Botanical Museum, Lund University, collected 5 miles east of Mokobulaan, Lydenburg, Transvaal, Union of South Africa, Oct. 21, 1953, by Ove Almborn (no. 7498; isotype in US).

Parmelia eruptens is characterized by rather large subirregular lobes and unusually large pustules which break open apically without soredial formation. It has much broader and more loosely attached lobes than other corticolous species containing divaricatic acid, such as *P. nairobiensis* Stein. & Zahlbr. and *P. texana* Tuck., though it is obviously related to these species. *Parmelia eruptens* is apparently endemic to South Africa.

Additional specimens examined: Union of South Africa: Transvaal: Mount Anderson, Sabie-Lydenburg, *Maas Geesteranus* 6453 (L, US),

6455 (L); Moçambique: Near Rock Pueshang, west of Martins Falls, Manica and Sofala distrs., *Mitchell* 332 (US).

5. *Parmelia heterochroa* Hale & Kurokawa, nom. nov.

Parmelia hypoxantha Stirt. Trans. New Zealand Inst. 32:76. 1899. Type collection: Warwick, Queensland, Australia, *Gwyther* s.n. (BM, holotype). Non *P. hypoxantha* Müll. Arg. Flora 64:85. 1881 (= *Chondropsis semi-viridis* Nyl.).

Parmelia tiliacea (Hoffm.) Ach. var. *stenophylla* Müll. Arg. Flora 66:46. 1883. Type collection: Toowoomba, Queensland, Australia, *Hartmann* s.n. (G, holotype).

P. tiliacea var. *rugulata* Müll. Arg. Nuov. Giorn. Bot. Ital. 23:388. 1891. Type collection: Brisbane, Australia, *Bailey* s.n. (G, lectotype).

P. tiliacea var. *convexula* Müll. Arg. Bull. Herb. Boiss. 4:90. 1896. Type collection: Brisbane, Australia, *Shirley* 1665 (G, holotype) [collector on label given as Bailey].

Type collection: Warwick, Queensland, Australia, *Gwyther* s.n. (BM).

Thallus adnate, mineral gray, turning olive buff in the herbarium, 4–12 cm. in diameter; lobes more or less dichotomously branched, sublinear-elongate, 1–4 mm. wide, 160–210 μ thick, the margins more or less crenate, often black-rimmed near the tips; upper surface plane to convex, smooth, shiny, irregularly rugose and cracked on older lobes, isidia and soredia lacking; medulla white above, capucine buff to zinc orange in the lower half; undersurface black, moderately to densely rhizinate, the rhizines black, simple, irregularly to squarrosely branched, 0.5–1.7 mm. long. Apothecia adnate, 1–5 mm. in diameter, exciple smooth to crenate or undulate, disc imperforate; hymenium 70–80 μ high; spores 7–8 \times 10–12 μ , episporium 1 μ thick.

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ rose, P+ orange red, pigment K+ purple, atranorine, protocetraric acid, and an unidentified anthraquinone pigment present.

This remarkable species is known only from Queensland, Australia, where it appears to be common. Superficially, it resembles *P. livida* Tayl. or even *P. brasiliiana* Nyl. but the lower medulla is conspicuously pigmented. The rhizines are mostly simple, though occasionally squarrosely branched. It is the only species outside of section *Parmelia* and section Irregulares that has squarrose rhizines, but it is clearly unrelated to these two sections. On a gross morphological basis we would prefer to put *P. heterochroa* in section *Hypotrachyna* but the peculiar rhizines indicate a closer affinity to section *Cyclocheila*.

Additional specimens examined: Australia: Toowoomba, Queensland, *Hartmann* 45 (G) (syntype of *P. tiliacea* var. *rugulata*); Queensland, *Bailey* 334 (BM).

6. *Parmelia imperfecta* Kurokawa, sp. nov.

Thallus arcte adnatus, saxicola, albido-cinereus, 2–4 cm. diametro, lobis sublinearibus, 0.5–2.0 mm. latis, margine crenatis, superne nitidus, isidiato-pustulatus, subtus niger, sparse rhizinosus, rhizinis nigris, simplicibus. Apothecia ignota.

Thallus closely or loosely adnate on rock, pale gull gray to light mineral gray (R), 2–4 cm. in diameter; lobes irregularly branched, sublinear-elongate, 0.5–2.0 mm. wide, 120–170 μ thick, the margins crenate; upper surface plane to more or less concave, shiny, irregularly cracked on older lobes, isidiate-pustulate, the pustules short, erupting; medulla white; undersurface black, sparsely rhizinate, the rhizines simple, about 0.2 mm. long. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K– or K+ yellowish, C–, KC–, P+ orange red, atranorine and an unknown P+ substance (forming small balls in G. A. o–T.) present.

Type in the Botanical Museum, Lund University, collected at the Cathedral Peak Area, Bergville, Natal, Union of South Africa, Nov. 2, 1953, by Ove Alborn (no. 8815; isotype in US).

Parmelia imperfecta is another saxicolous lichen endemic to South Africa. It is apparently related to *P. annexa* Kurokawa, *P. arcana* Kurokawa, and *P. molybdiza* Nyl. The pustules are rather sparse, thick and short and burst open apically without formation of soredia. Almost identical pustules are found in the saxicolous Japanese species *P. owariensis* Asah., which differs principally in containing divaricatic acid.

Additional specimens examined: Union of South Africa: Transvaal: Punch Bowl Inn, north of Louis Trichardt, Alborn 6491 (LD); Louis Trichardt, near Punch Bowl, Zoutpansberg, Alborn 6108 (LD, US).

7. *Parmelia ischnoides* Kurokawa, sp. nov.

PLATE 4

Thallus arcte adnatus, saxicola, cinereo-albicans, 4–10 cm. latus, lobis sublinearibus, 0.5–2.0 mm. latis, superne nitidus, emaculatus, isidiatus, subtus niger, sparse rhizinosus, rhizinis nigris, simplicibus. Apothecia adnata, 1–2 mm. diametro; hymenium 70–80 μ altum; sporae 5–6 \times 7–8 μ .

Thallus closely adnate on rock, pearl gray to mineral gray (R), 4–10 cm. in diameter; lobes irregularly branched, sublinear-elongate, more or less imbricate with age, 0.5–2.0 mm. wide, 200–280 μ thick, the margins entire to subcrenate; upper surface plane to convex, shiny, not maculate, isidiate, the isidia cylindrical, short and simple, darkening apically; medulla white; undersurface black, sparsely rhizinate, the rhizines black, simple. Apothecia adnate, 1–2 mm.

in diameter, exciple more or less crenate, amphithecium isidiate, disc light seal brown (R); hymenium 70–80 μ high; spores 5–6 \times 7–8 μ .

Reactions: Thallus K+ yellow; medulla K+ yellow, C–, KC–, P+ pale orange, atranorine and stictic acid present.

Type in the Botanical Museum, Lund University, collected on rocks near Window Stream, Kirstenbosch, Wynberg, Cape Province, Union of South Africa, Aug. 3, 1953, by Ove Alborn (no. 1698; isotype in US).

Parmelia ischnoides adds still another member to that unique group of saxicolous species so common in the Cape region (see discussions under *P. annexa* and *P. imperfecta*). It is characterized by adnate, linear and more or less separate lobes as illustrated in plate 4 to broad and more crowded lobes up to 2 mm. wide. Isidia are often quite dense but always rather small or even at times papillate. The chemical component, stictic acid, is quite rare in the section *Cyclocheila*.

Additional specimens examined: Union of South Africa: Cape Province: Kirstenbosch, Wynberg Distr., *Alborn* 124, 1443 (LD); Window Gorge, Wynberg Distr., *Alborn* 788 (LD); near Kloof Neck, Camps Bay Road, Cape Distr., *Alborn* 864 (LD).

8. *Parmelia pustulescens* Kurokawa, sp. nov.

PLATE 4

Thallus arcte adnatus, saxicola, albido-cinerascens, 3–5 cm. latus, lobis sublinearibus, 0.3–1.2 mm. latis, margine crenatis, superne nitidus, emaculatus, isidiatus, isidiis irregulariter inflatis, demum apice pustulescentibus, subtus niger, sparse rhizinosus, rhizinis nigris, simplicibus. Apothecia adnata, 0.7–2.0 mm. diametro; hymenium 45–55 μ altum; sporae 4–5 \times 7–9 μ .

Thallus tightly adnate on rock, pearl gray to light mineral gray (R), 3–5 cm. in diameter; lobes dichotomously to irregularly branched, sublinear-elongate, 0.3–1.2 mm. wide, 100–130 μ thick, the margins crenate, narrowly black-rimmed near the tips; upper surface plane and shiny, without maculae, irregularly cracked on older lobes, isidiate, the isidia cylindrical, irregularly inflated, at length bursting open apically; medulla white; undersurface black, sparsely rhizinate, the rhizines simple, black, 0.1–0.2 mm. long. Apothecia adnate, 0.7–2.0 mm. in diameter, exciple isidiate-pustulate, disc clove brown (R); hymenium 45–55 μ high; spores 4–5 \times 7–9 μ .

Reactions: Thallus K+ yellow; medulla K–, C–, KC–, P–, atranorine and caperatic acid present.

Type in the herbarium of G. Degelius, collected near Fazenda Canjangué, Vila Flor, Humbo, Angola, Feb. 18, 1960, by G. Degelius (isotype in US).

Parmelia pustulescens is an adnate saxicolous lichen virtually indistinguishable from *P. imperfecta* Kurokawa and *P. owariensis* Asah.

in the development of pustules. (See discussion under *P. imperfecta*.) *Parmelia pustulescens* differs chiefly in containing caperatic acid. It is known only from the type specimen.

9. *Parmelia salacinifera* Hale, sp. nov.

PLATE 9

Thallus adnatus, corticola, olivaceo-albicans, 6–12 cm. diametro, lobis subirregularibus, subrotundatis, 3–6 mm. latis, 170–190 μ crassis, superne planus, nitidus, modice isidiatus, subtus pallide castaneus, modice rhizinosus, rhizinis concoloribus, simplicibus, ambitu anguste nudus vel papillatus. Apothecia adnata, 2–4 mm. diametro; hymenium 30–38 μ altum; sporae non evolutae.

Thallus adnate, corticolous, olivaceous to mineral gray, 6–12 cm, in diameter; lobes subirregular, 3–6 mm. wide, 170–190 μ thick, apically subrotund, the margins entire to subcrenate; upper surface plane, rugose and fissured with age, shiny, moderately isidiate, the isidia cylindrical, usually simple, 0.04–0.08 \times 0.16–0.30 mm.; under-surface pale brown, moderately rhizinate, the rhizines pale brown, simple, the marginal zone bare or papillate. Apothecia adnate, 2–4 mm. in diameter, amphithecium isidiate, disc imperforate; hymenium 30–38 μ high; spores not developed.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C–, KC–, P+ pale orange red, atranorine and salacinic acid present.

Type in the U.S. National Herbarium, collected at Sanford, Seminole County, Florida, March 1925, by S. Rapp (isotype in FLAS).

Parmelia salacinifera is a typical member of section *Cyclocheila* with irregular subrotund lobes. The thallus is usually quite closely adnate on bark. At first glance it seems indistinguishable from *P. amazonica* Nyl., which occurs from Florida to Brazil; *P. amazonica* has a jet black undersurface and protocetraric acid. *Parmelia salacinifera* undoubtedly occurs generally in the Caribbean region. A typical habitat is burned palm trunks in pastures.

Additional specimens examined: Georgia: 5 mi. SW. of Waycross, Ware Co., *Hale* 16843 (US). Florida: Tomoka State Forest, Volusia Co., *Hale* 17063 (US); near Pensacola, Escambia Co., *Hale* 7994 (US); Dog Lake Recreation Area, *Hale*, 16714 (US); 6 mi. SW. of Tallahassee, Leon Co., *Hale* 16984 (US); Orange Park, Clay Co., *Hale* 17735 (US); vicinity of Fort Myers, Lee Co., *Standley* 13084 (US); Sanford, Seminole Co., *Rapp* 472, May 1919, February 1924 (FLAS). Mexico: Km. 956 on Hwy. 190, west of Ocozocoautla, Chiapas, *Hale* 20607 (US). Brazil: Mato Grosso: Bocca da Serra, *Malme* s.n. (UPS).

10. *Parmelia tortula* Kurokawa, sp. nov.

PLATE 4

Thallus adpressus, saxicola, albido-cinerascens, 5–10 cm. latus, lobis subirregularibus vel sublinearibus, apice subrotundatus, 1.5–4.0 mm. latis, margine crenatis, superne nitidus, emaculatus, isidiis

sorediisque destitutus, subtus pallide castaneus, sparse rhizinosus, rhizinis castaneis, simplicibus. Apothecia adnata vel substipitata, 1–5 mm. diametro; hymenium 40–50 μ altum; sporae 5–6 \times 7–9 μ .

Thallus closely adnate on rock, yellowish glaucous to light olive gray (R), 5–10 cm. in diameter; lobes irregularly branched, subirregular to sublinear-elongate, more or less subrotund apically, often twisted and contorted, 1.5–4.0 mm. wide, 180–220 μ thick, the margins entire to crenate, black-rimmed at the tips; upper surface shiny, often faintly pruinose, without maculae, rugulose and distinctly cracked on older lobes, isidia and soredia lacking; medulla white; undersurface pale brown, sparsely rhizinate, the rhizines simple, pale brown, about 0.3 mm. long. Apothecia adnate to substipitate, 1–5 mm. in diameter, exciple and amphithecium smooth, disc bone brown (R); hymenium 40–50 μ high; spores 5–6 \times 7–9 μ .

Reactions: Thallus K+ yellow; medulla K–, C–, KC–, or KC+ faint rose, P–, atranorine and unknown colorless substances present.

Type in the Botanical Museum, Lund University, collected on rocks between O'okiep and Springbok, Namaqualand, Cape Province, Union of South Africa, Sep. 15, 1953, by Ove Alborn (no. 4805; isotype in US).

Parmelia tortula is a saxicolous species common in the Cape region and obviously related to *P. molybdiza* Nyl. Generally it is larger and the colonies more extensive than in *P. molybdiza*. The lobes are often more or less twisted and, at least near the tips, partially free of the substratum; *P. molybdiza* is less robust and contains lecanoric acid. The chemistry of *P. tortula* is not entirely clear at this time. The KC+ test is variable, often weak or absent. Microchemical tests have not revealed the cause of this reaction.

Additional specimens examined: Union of South Africa: Orange Free State: Thabanchis, Höeg, Aug. 12, 1929 (TRH); Cape Province: 4 miles south-southwest of Oudtshoorn, Oudtshoorn Distr., Alborn 4199 (LD); Saldanha, Malmesbury Distr., Alborn 4988, 4996 (LD); Sea Point, Cape Town, Wynberg Distr., Höeg, May 31, 1929 (TRH); Dordrecht, Höeg, Nov. 21, 1929 (TRH).

11. *Parmelia violacea* Kurokawa, sp. nov.

Thallus adpressus vel adnatus, saxicola, olivaceo vel viridi-cinereus, 3–6 cm. diametro, lobis sublinearibus, 1–3 mm. latis, margine crenatis, superne nitidus, emaculatus, isidiis sorediisque destitutus, medulla purpureus, subtus pallide castaneus, modice rhizinosus, rhizinis castaneis, simplicibus. Apothecia adnata, 1.0–1.5 mm. diametro; sporis non visis.

Thallus closely adnate on rock, smoke gray to dark olive gray (R), 3–6 cm. in diameter; lobes irregularly branched, sublinear-elongate, 1–3 mm. wide, 160–200 μ thick, the margins crenate; upper surface shiny, without maculae, distinctly rugulose on older lobes, isidia and soredia lacking; medulla vinaceous purple to indian purple (R); undersurface pale brown, moderately rhizinate, the rhizines pale brown, simple, 0.5–1.0 mm. long. Apothecia adnate, 1.0–1.5 mm. in diameter, exciple and amphithecium smooth, disc cameo brown to vandyke brown (R); mature spores not seen.

Reactions: Thallus K+ yellow; medulla K+ deep purple, P–, atranorine and an unidentified hydroxanthraquinone present.

Type in the Botanical Museum, Lund University, collected at Blinkwater Ravine, slopes of Table Mountain, Cape Province, Union of South Africa, Aug. 5, 1953, by Ove Alborn (no. 1771; isotype in US).

Parmelia violacea has a brilliant deep rusty-red medulla, frequently exposed as the upper cortex breaks away. In this respect it is very similar to *P. endomiltoides* Nyl., a *Xanthoparmelia* species with usnic acid and two unidentified pigments, one of them (of lower R₁) identical with that in *P. violacea*. Both of these species are found on Table Mountain in Cape Province.

5. Section *Hypotrachyna* Vain. (1890, p. 38)

Section *Hypotrachyna** *Sublinearis* Vain. (1890, p. 50).

Section *Sublineares* (Vain.) Vain. (1923, p. 34).

Section *Hypotrachyna* subsection *Sublineares* (Vain.) Gyel. (1932, p. 223).

Section *Hypotrachyna* subsection *Sublineares* (Vain.) Hillm. (1934, p. 187).

Superfluous combination.

Type species: *Parmelia brasiliiana* Nyl.

Thallus adnate to loosely attached and subdivaricate; lobes sublinear to linear-elongate; lower surface jet black, the rhizines more or less richly dichotomously branched.

The type species of this section should be selected from the Brazilian species cited in Vainio's original study. We believe that he considered his group *Sublinearis* to represent the typical concept of section *Hypotrachyna* and *P. brasiliiana* Nyl. to be a typical species in this group. Two other groups described at the same time, *Cyclocheila* (= section *Cyclocheila* (Vain.) Räs.) and *Irregularis* (= section *Irregulares* (Vain.) Vain.), were described as having subirregular rotund lobes with a narrow bare zone below. In his study of Philippine lichens, Vainio (1923) put the subirregular species into a new section (*Irregulares*) and the sublinear species into section *Sublineares* (Vain.) Vain. He included *Parmelia americana* (Mey. & Flot.) Mont. and *P. sorocheila*

Vain. in section *Sublineares*, but these are everniiform species that should be transferred to the genus *Pseudevernia* Zopf.

As we have delimited section *Hypotrachyna*, it does not include *P. saxatilis* (L.) Ach., the type of section *Parmelia*, which has pseudocyphellae and squarrosely branched rhizines. For this reason, section *Parmelia*, which includes *P. saxatilis*, and section *Hypotrachyna* cannot be considered as synonymous.

Section *Hypotrachyna* is the largest yet surprisingly the most homogeneous group of species in subgenus *Parmelia*. All species have a black lower surface with more or less distinctly dichotomously branched rhizines, sometimes so dense as to form a marginal mat projecting beyond the margins. Cilia are absent, although projecting branched rhizines might be mistaken for cilia. The greatest concentration of species is in tropical America, where 48 of the 83 species are endemic. Fourteen species are endemic to Asia and only six to Africa.

Morphological and chemical diversity reach a peak in this section. There is an abundance of sorediate species (14). There are a number of acids not found in any of the other sections of subgenus *Parmelia* except section *Cyclocheila* (cf. table 1). These include alectoronic acid, barbatic acid, divaricatic acid, evernic acid, lichexanthone, olivetoric acid, and perlatolic acid. All of these substances are negative with KOH, paraphenylenediamine, calcium hypochlorite (except for olivetoric acid), and most are KC+ red and more or less fluorescent in ultraviolet light. In addition, if depsides, they have a basic 2-methoxy substitution on the acid ring (cf. Asahina and Shibata, 1954, p. 54), whereas the other depsides usually have a 2-hydroxy substitution. The full significance of this chemical variation has not yet been assessed, but the overall correlation between the chemical constituents and our sectional classification appears to be sound.

Key to Species in Section *Hypotrachyna* Vain.

1. Thallus isidiate I.
1. Thallus lacking isidia.
 2. Thallus sorediate or pustulate II. (p. 161).
 2. Thallus lacking isidia, soredia, or pustules III. (p. 163).

I. THALLUS ISIDIATE

1. Medulla yellow, the pigment K—.
2. Medulla C—; isidia dense **P. isidiocera** Nyl.
2. Medulla C+ red (unknown); isidia variable, sparse, simple to coralloid.
 23. **P. prolongata** Kurokawa
1. Medulla white, or if pigmented, the pigment K+ purple.
 3. Upper cortex distinctly maculate.
 4. Medulla K—, C—, KC—, P— (fatty acids) . . . **P. costaricensis** Nyl.

4. Medulla P+ yellow to red or KC+ red or orange.
5. Medulla K+ yellow, P+ yellow (unknown).
 9. *P. dentella* Hale & Kurokawa
5. Medulla K-, KC+ red or orange.
 6. Medulla C-, KC+ orange (barbatic acid).
 7. Isidia cylindrical *P. imbricatula* Zahlbr.
 7. Isidia lobulate, dorsiventral *P. digitata* Lynge
 6. Medulla C-, KC+ rose (evernic acid).
 8. Isidia cylindrical *P. bogotensis* Vain.
 8. Isidia lobulate, dorsiventral *P. culmigena* Zahlbr.
3. Upper cortex not distinctly maculate.
 9. Medulla P+ yellow to orange red.
 10. Medulla K- (protocetraric acid).
 11. Medulla ochraceous yellow in the lower half . . . *P. consimilis* Vain.
 11. Medulla entirely white *P. koyaensis* Asah.
 10. Medulla K+ yellow or red.
 12. Thallus yellowish green (usnic acid); norstictic acid present.
 - P. microblasta* Vain.
 12. Thallus grayish green (usnic acid lacking).
 13. Rhizines finely branched; isidia mostly simple; norstictic acid present 24. *P. rhabdiformis* Kurokawa
 13. Rhizines sparsely to moderately branched; isidia often branched; stictic acid present 5. *P. crenata* Kurokawa
 9. Medulla P-.
 14. Medulla C+ red or yellow or KC+ red or orange.
 15. Medulla C+ deep red, KC+ red (unknown).
 23. *P. prolongata* Kurokawa
 15. Medulla C- or C+ yellow, KC+ orange (barbatic acid).
 16. Isidia cylindrical *P. imbricatula* Zahlbr.
 16. Isidia lobulate, dorsiventral *P. digitata* Lynge
 14. Medulla C-, KC-, or KC+ red.
 17. Medulla KC+ red or rosy.
 18. Isidia inflated or pustular; medulla usually ochraceous yellow under the isidia *P. dactylifera* Vain.
 18. Isidia simple or lobulate; pigments absent.
 19. Isidia lobulate, dorsiventral; alectoronic acid present.
 10. *P. ensifolia* Kurokawa
 19. Isidia cylindrical; KC+ unknown present.
 - P. nodakensis* Asah.
 17. Medulla C-, KC-; fatty acids present.
 20. Upper cortex weakly maculate; rhizines densely branched; America *P. costaricensis* Nyl.
 20. Upper cortex without maculae; rhizines moderately branched; Asia.
 18. *P. infirma* Kurokawa

II. THALLUS SOREDIATE OR PUSTULATE

1. Pustules distinct, without soredia or only very sparsely sorediate.
 2. Thallus yellowish green (usnic acid) *P. meyeri* Zahlbr.
 2. Thallus mineral gray (usnic acid lacking).
 3. Medulla pale yellow orange, pigment K- . . . *P. endochlora* Leight.
 3. Medulla white or in part pigmented, pigment K+ purple.
 4. Pigments present, K+ purple.

5. Thallus 2-4 cm. broad, the lobes up to 1 mm. wide . **P. malmei** Lyngé
5. Thallus 3-10 cm. broad, the lobes 1.0-2.5 mm. wide.
P. formosana Zahlbr.
4. Pigments absent.
6. Medulla C+ rose (gyrophoric acid) **P. revoluta** Floerke
6. Medulla C-, KC+ orange (barbatic acid).
7. Pustules distinct, becoming sorediate; Asia **P. exsecta** Tayl.
7. Pustules irregular, esorediate; cortex fragile; North America.
29. P. virginica Hale
1. Pustules indistinct or absent; soredia usually abundant, farinose.
8. Upper cortex distinctly maculate.
9. Medulla pale yellow orange throughout **P. endochlora** Leight.
9. Medulla white.
10. Medulla KC+ orange (barbatic acid) **P. laevigata** (Sm.) Ach.
10. Medulla KC+ red or rose.
11. Evernic acid present **P. rockii** Zahlbr.
11. Alecoronic acid present **13. P. exsplendens** Hale
8. Upper cortex without maculae or at most in part faintly maculate.
12. Thallus yellowish green (usnic acid).
13. Medulla K+ yellow turning red (salacinic acid).
P. sinuosa (Sm.) Ach.
13. Medulla K-, P+ orange red (protocetraric acid).
14. Soralia mainly terminal; medulla ochraceous (rhodophyscin) under the soralia **P. velloziae** Vain.
14. Soralia mainly subterminal; pigments lacking.
15. P. flavovirens Kurokawa
12. Thallus mineral gray (usnic acid lacking).
15. Medulla P+ yellow to orange red.
16. Medulla K+ yellow turning to red (salacinic acid).
17. Rhizines moderately branched; zeorine present.
P. majoris Vain.
17. Rhizines finely branched; zeorine absent.
2. P. brevirhiza Kurokawa
16. Medulla K-.
18. Lichexanthone present; P+ unknown present.
P. subaffinis Zahlbr.
18. Lichexanthone absent; protocetraric acid present.
19. Orange-red pigment (rhodophyscin) under the soralia.
6. P. croceopustulata Kurokawa
19. Pigments absent under the soralia.
20. Lobes 1.5-2.0 mm. wide; soralia mostly subterminal.
P. pseudosinuosa Asah.
20. Lobes 0.5-1.0 mm. wide; soralia mostly laminal.
1. P. anaptychioides Kurokawa
15. Medulla P-.
21. Orange-yellow pigment (rhodophyscin) under the soralia.
19. P. leiophylla Kurokawa
21. Pigments absent.
22. Medulla C+ rose, red, or orange red.
23. Medulla C+ red or orange red (olivetic acid).
21. P. lividescens Kurokawa
23. Medulla C+ rose (gyrophoric acid).

24. Lobes linear-elongate, subdivaricate; Mexico.
28. P. thysanota Kurokawa
 24. Lobes loosely adnate, sublinear; Africa . . . **P. revoluta** Flk.
 22. Medulla C—, KC+ red or orange red.
 25. Medulla KC+ orange (barbatic acid) . . . **P. rockii** Zahlbr.
 25. Medulla KC+ rose or red.
 26. KC+ unknown present; Africa.
17. P. immaculata Kurokawa
 26. Alecoronic acid present; tropical America.
 27. Lobes linear-elongate, subdivaricate.
8. P. densirhizinata Kurokawa
 27. Lobes sublinear, loosely adnate to subimbricate.
13. P. exsplendens Hale

III. THALLUS LACKING ISIDIA, SOREDIA, AND PUSTULES

1. Thallus yellowish green (usnic acid).
 2. Thallus saxicolous **P. flavida** Zahlbr.
 2. Thallus corticolous.
 3. Medulla K—, P+ orange red **P. flavida** Zahlbr.
 3. Medulla K+ red, P+ orange red.
 4. Salacinic acid present **4. P. citrella** Kurokawa
 4. Norstictic acid present.
 5. Thallus closely adnate; lobes sublinear; rhizines densely branched.
P. reducens Nyl.
 5. Thallus loosely adnate to subdivaricate; lobes linear-elongate;
 rhizines moderately branched.
 6. Lobes 1-2 mm. wide, sparsely rhizinate, subimbricate.
P. enderythraea Zahlbr.
 6. Lobes 2-4 mm. wide, densely rhizinate, subdivaricate.
P. caraccensis Tayl.
1. Thallus mineral gray (usnic acid lacking).
 7. Medulla pale yellow or in part ochraceous.
 8. Pigment K—.
 9. Apothecia stalked; rhizines richly branched . . . **P. peruviana** Nyl.
 9. Apothecia adnate; rhizines sparsely to moderately branched.
25. P. rigidula Kurokawa
 8. Pigment K+ purple to purple black.
 10. Thallus orange fluorescent under UV light (lichexanthone present).
 11. Upper cortex maculate; thallus corticolous . . . **P. silvatica** Lynge
 11. Upper cortex not maculate; thallus saxicolous.
 12. Medulla C+ red (olivetric acid) . . . **P. osteoleuca** Nyl.
 12. Medulla C—, P+ red (unknown).
11. P. erythrodes (Zahlbr.) Hale & Kurokawa
 10. Thallus not fluorescent (lichexanthone absent).
 13. Medulla P+ red (protocetraric acid) **P. bahiana** Nyl.
 13. Medulla P— (fatty acids) **P. lythgoeana** Dodge
7. Medulla white, no pigments present.
 14. Medulla P+ yellow to orange red.
 15. Medulla K+ yellow turning red.
 16. Norstictic acid present **3. P. canescens** Kurokawa
 16. Salacinic acid present.

17. Thallus corticolous; rhizines densely branched.
P. sublaevigata (Nyl.) Nyl.
17. Thallus saxicolous; rhizines moderately branched
P. subsaxatilis B. de Lesd.
15. Medulla K— or K+ faint brownish.
18. Thallus saxicolous.
19. Cortex orange fluorescent in UV light (lichexanthone present).
P. brasiliiana Nyl.
19. Cortex not fluorescent (lichexanthone absent).
P. osseoalbida Lynge
18. Thallus corticolous.
20. Medulla KC+ orange (barbatic acid present).
26. P. scytodes Kurokawa
20. Medulla KC+ rose (protocetraric acid present).
21. Spores 15–25 μ long.
22. Spores 20–25 μ long; fatty acid present. **P. keitauensis** Asah.
22. Spores 15–20 μ long; fatty acids lacking.
P. manilensis Vain.
21. Spores 8–12 μ long.
23. Apothecia large, the disc split radially; Africa.
14. P. fissicarpa Kurokawa
23. Apothecia small, the disc entire; tropical America.
24. Rhizines moderately branched lobes subrotund often, whitish pruinose **P. insinuans** Nyl.
- 24 Rhizines fine, densley branched; lobes sublinear, epruinose.
P. bahiana Nyl.
14. Medulla P—.
25. Medulla C—, KC+ orange (barbatic acid).
26. Thallus subdivaricate, the lobes linear-elongate; rhizines mostly moniliform **22. P. monilifera** Kurokawa
26. Thallus adnate, the lobes sublinear; rhizines normal, not moniliform.
27. Upper cortex distinctly maculate **P. boliviana** Nyl.
27. Upper cortex not distinctly maculate.
28. Amphithecium strongly rugose; Java.
P. bostrychodes Zahlbr.
28. Amphithecium smooth; tropical America.
29. Lobes sublinear to linear-elongate; rhizines densely branched.
P. physcioides Nyl.
29. Lobes shorter, subimbricate; rhizines sparsely to moderately branched **P. zahlbruckneri** Lynge
25. Medulla C+ rose or red or C—, KC+ red.
30. Medulla C+ rose (gyrophoric acid).
31. Lobes linear-elongate, subdivaricate.
12. P. exporrecta Kurokawa
31. Lobes sublinear, adnate.
32. Lobes plane to more or less canaliculate, pale brown in a rather wide zone at the margins below; spores 14–21 μ long.
P. pluriformis Nyl.
32. Lobes plane, pale brown only in a very narrow zone below; spores to 12 μ long.
33. Thallus large, 4–8 cm. broad, the lobes 2–4 mm. wide.
27. P. scytophylla Kurokawa

33. Thallus smaller, 2–5 cm. broad, the lobes 1–2 mm. wide.
P. revolutella Nyl.
30. Medulla C+ red or C– (gyrophoric acid lacking).
34. Medulla C+ red to orange red (olivetic acid).
P. intercalanda Vain.
34. Medulla C–.
35. Medulla KC+ red (alectoronic acid).
36. Thallus adnate, the lobes sublinear. . . . 7. **P. degelii** Hale
36. Thallus loosely attached, subdivaricate.
37. Lobes narrow, 1–2 mm. wide.
20. P. lineariloba Kurokawa
37. Lobes wider, 2–4 mm. wide.
38. Rhizines densely branched, about 1 mm. long; tropical America 16. **P. gigas** Kurokawa
38. Rhizines moderately branched, 2 mm. or more long; Hawaii **P. cervicornis** Tuck.
35. Medulla KC+ rose (alectoronic acid absent).
39. Upper cortex distinctly maculate. **P. pulvinata** Fée
39. Upper cortex not distinctly maculate.
40. Upper cortex flaking away, fragile; evernic acid present.
P. taylorensis Mitch.
40. Upper cortex continuous, not flaking; KC+ unknown substances present.
41. Spores uniseriate, 6–8 μ long; North America.
P. livida Tayl.
41. Spores biseriate, 14–18 μ long; South America.
42. Thallus corticolous; apothecial disc flesh-colored.
P. damaziana Zahlbr.
42. Thallus saxicolous; disc dark brown.
P. gracilescens Vain.

1. Parmelia anaptychioides Kurokawa, sp. nov.

PLATE 5

Thallus adnatus, cinereo-albicans, 2–5 cm. diametro, lobis sublinearibus, separatis, 0.5–2.0 mm. latis, superne plus minusve convexus, sorediatus, subtus niger, rhizinosus, rhizinis nigris, dichotome ramosis. Apothecia ignota.

Thallus adnate on bark, pale olive gray to gray (R), 2–5 cm. in diameter; lobes dichotomously branched, sublinear-elongate, separate at the circumference, 0.5–2.0 mm. wide, 160–220 μ thick, the margins smooth, narrowly black-rimmed; upper surface more or less convex, shiny on younger lobes, dull and irregularly cracked on older lobes, soresiate, the soresia mainly laminal, 1–2 mm. in diameter, often fusing; medulla white; undersurface black, dark brown in a narrow zone at the tips, the rhizines black, branched. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ faint red, P+ orange red, atranorine and protocetraric acid present.

Type in Michigan State University, collected on low ridge connecting La Rucilla and Pico Trujillo, Maciso Central, Cordillera Central,

elev. 8000 ft., Dominican Republic, August 8, 1958, by C. Wetmore (no. 3617; isotype in US).

This species is related to *P. pseudosinuosa* Asah. but the soralia are mainly laminal. The lobes are sublinear to linear-elongate and narrower than in *P. pseudosinuosa*. It is also close to *P. subaffinis* Zahlbr., especially in size and position of soralia, but it is differentiated by the absence of lichexanthone. *Parmelia anaptychioides* is known only from the West Indies, where it occurs on pine trees at higher elevations.

Additional specimens examined: Jamaica: Blue Mountain Peak, 7000 ft., *Imshaug* 15533 (MSC). Haiti: South of Forêt des Pins, 5500 ft., Dept. l'Ouest, *Imshaug* 22779 (MSC).

2. *Parmelia brevirhiza* Kurokawa, sp. nov.

PLATE 3

Thallus adnatus, ca. 5 cm. diametro, olivaceo-cinerascens, lobis subirregularibus, 1–4 mm. latis, subrotundatis, margine crenatis, superne opacus vel nitidulus, submaculatus, partim leviter albo-pruinosis, sorediatus, sorediis capitatis, subtus niger, dense brevirhizinosus, rhizinis nigris, dichotome ramosis. Apothecia rara, adnata, usque ad 5 mm. diametro; hymenium 50–55 μ altum; sporae male evolutae, 3–4 \times 6–8 μ .

Thallus adnate on bark, cream buff (R), about 5 cm. in diameter; lobes subirregular to sublinear, more or less subrotund and subimbricate, 1–4 mm. wide, 140–170 μ thick, the margins subcrenate; upper surface plane to rugulose, shiny and more or less white-maculate to dull and lightly white-pruinose, soresiate, the soredia mostly subterminal, strongly capitate, diffuse, medulla white; undersurface black, densely short rhizinate, dark brown and papillate in a very narrow zone at the tips, the rhizines black, finely branched, about 0.1 mm. long, projecting as a narrow mat beyond the margins. Apothecia very rare, adnate, to 5 mm. in diameter, amphithecium soresiate, disc plane; hymenium 50–55 μ high; spores poorly developed, 3–4 \times 6–8 μ .

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C–, KC– P+ pale orange red, atranorine and salacinic acid present.

Type in the Naturhistoriska Riksmuseet, Stockholm, collected in *Nothofagus* rain forest, Isla Riesco, Mina Elena, Terr. Magallanes, Chile, Apr. 29, 1940, by R. Santesson (no. 2066; isotype in US).

Parmelia brevirhiza has a distinct whitish cast, caused by faint pruinosity, and large subterminal and projecting soralia 2–4 mm. in diameter. The soresiate lobes are strongly revolute or contorted. This species resembles *P. majoris* Vain., which is known from Asia and Madagascar, in the presence of soredia and salacinic acid. *Parmelia brevirhiza* has more densely branched rhizines, which form a mat on the undersurface. *Parmelia majoris* contains zeorine in

addition to salacinic acid. *Parmelia brevirhiza* is very common in southern Argentina and Chile and there is one quite unexpected record from Java.

Additional specimens examined: Argentina: Lago Roca, *Santesson* 1085 (S); Río Piper, Ushuaia, Tierra del Fuego, *Santesson* 417 (S); Lago Verde, near Futalaufquen, Prov. Chubut, *Lamb* 5864 (CAN, US). Chile: Punta Guapacho, Peninsula Lacui, Isla Chiloé, Prov. Chiloé, *Santesson* 4135 (S); Cerros Divisaderos, Coyhaique, Terr. Aysén, *Santesson* 4456 (S); Mina Elena, Isla Riesco, *Santesson* 7849 (S); Estancia Maria, Seno Skyring, Terr. Magallanes, *Santesson* 1974, 1997 (S); Puerto Yartou, Canal Whiteside, *Santesson* 5791, 6759 (S); Río Condor, south of Puerto Yartou, Canal Whiteside, *Santesson* 5905 (S); Puerto Navarino, Isla Navarino, *Santesson* 7404 (S, US); Porvenir, Tierra del Fuego, *Santesson* 5372 (S). Java: Near Madang-Aer Batumbuk, *Groenhart* 9268 (BO).

3. *Parmelia canescens* Kurokawa, sp. nov.

Thallus adnatus, corticola, olivaceo-albicans, 3–7 cm. latus, lobis irregularibus, subrotundatis, 1–5 mm. latis, margine subcrenatis, superne opacus, parte albo-pruinosis, isidiis sorediisque destitutus, subtus niger, rhizinosus, rhizinis nigris, sparse vel modice ramosis, Apothecia adnata, 1.5–4.5 mm. diametro; hymenium 40–50 μ altum; sporae 5–6 \times 8–10 μ .

Thallus adnate on twigs, pale olive buff (R), 3–7 cm. in diameter; lobes irregularly branched, subrotund apically, 1–5 mm. wide, the margins more or less crenate, rarely lobulate; upper surface plane, dull, sometimes faintly white-pruinose, not maculate, irregularly rugose or cracked on older lobes, isidia and soredia lacking; medulla white; undersurface uniformly black, sparsely to moderately branched; rhizines black, moderately branched, about 0.5 mm. long. Apothecia adnate, amphithecium rugulose, pruinose, disc vandyke brown (R); hymenium 40–50 μ high; spores 5–6 \times 8–10 μ .

Reactions: Thallus K+ yellow; medulla K+ yellow turning red C—, KC—, P+ pale orange, atranorine and norstictic acid present.

Type in the Naturhistoriska Riksmuseet, Stockholm, collected at Hacienda de Cayquenes, Colchagua, Chile, Aug. 22, 1896, by P. Dusén (no. 92; isotype in US).

Parmelia canescens externally resembles *P. sublaevigata* (Nyl.) Nyl. in having a similar adnate thallus and irregularly branched lobes. *Parmelia canescens* contains norstictic acid, whereas *P. sublaevigata* contains salacinic acid. Moreover, the rhizines of *P. canescens* are sparsely to moderately branched while those of *P. sublaevigata* are more densely and finely branched. It is hoped that further collections of these rare species will further clarify their relationships.

4. *Parmelia citrella* Kurokawa, sp. nov.

Thallus adnatus, corticola, viridiflavicans, 3–8 cm. latus, lobis sublinearibus, subimbricatis, 1.0–2.5 mm. latis, superne nitidulus, isidiis sorediisque destitutus, subtus niger, rhizinosus, rhizinis nigris, furcatis. Apothecia adnata, 2–10 mm. diametro; hymenium 25–35 μ altum; sporae 7–9 \times 12–14 μ .

Thallus adnate on bark, sea-foam yellow (R), 3–8 cm. in diameter; lobes dichotomously branched, sublinear to linear-elongate, more or less imbricate, 1.0–2.5 mm. wide, 90–140 μ thick, the margins smooth, often narrowly black-rimmed; uppersurface plane to convex, rather shiny, isidia and soredia lacking, pycnidia forming blackish papillae on older lobes; medulla white; undersurface black, rhizinate, the rhizines black, rather long, moderately branched, often projecting beyond the margins. Apothecia adnate, 2–10 mm. in diameter, exciple crenate to undulate, disc Hay's brown to light seal brown (R), radially split, amphithecium smooth to rugose; hymenium 25–35 μ high; spores 7–9 \times 12–14 μ .

Reactions: Thallus K+ yellowish; medulla K+ yellow turning red, C–, KC–, P+ pale orange red, usnic acid and salacinic acid present.

Type in the Herbarium Bogoriense, collected at G. Gedeh, Java, elev. 2900 m., March 7, 1938, by H. van Woerden (isotype in US).

Parmelia citrella is very close to *P. reducens* Nyl., but the thallus is more loosely attached and the rhizines are consistently longer. *Parmelia reducens* also differs chemically in producing norstictic acid, and on the basis of a few measurements the spores seem to be slightly smaller (9–11 μ long). *Parmelia citrella* appears primarily to be an Indonesian species, while *P. reducens* is known only from South America.

Additional specimens examined: Panama: Craters edge, Volcán Chiriquí, Prov. Chiriquí, *Scholander*, Dec. 5–12, 1948 (MO, US). Colombia: Sierra de Santa Maria, elev. 8000 ft., *Humbry-Troy* 313 (K). Java: G. Gedeh, *van Woerden* 2023 (BO); G. Pangerango, *Reijnvaan* 150 (BO); no locality, *Horsfield* (BM).

5. *Parmelia crenata* Kurokawa, sp. nov.

Thallus laxe adnatus, muscicola, albido-cinerascens, 3–6 cm. diametro, lobis subirregularibus, subimbricatis, apice subrotundatis vel subtruncatis, 1.5–5.0 mm. latis, margine crenatis, superne laevigatus, emaculatus, isidiatus, subtus niger, ambitu castaneus, sparse rhizinosus, rhizinis nigris, modice furcatis. Apothecia ignota.

Thallus loosely attached, growing over mosses on rocks, yellowish glaucous to light mineral gray (R), 3–6 cm. in diameter; lobes irregularly branched, more or less imbricate, rounded at the tips,

1.5–5.0 mm. wide, 90–110 μ thick, the margins crenate; upper surface smooth, without maculae, moderately isidiate, the isidia short, less than 0.5 mm. high, often branched; medulla white; undersurface black, pale brown in a narrow zone at the tips, sparsely rhizinate, the rhizines black, sparsely to moderately branched. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow, C–, KC–, P+ pale orange, atranorine and stictic acid present.

Type in the National Science Museum, Tokyo, collected on Mount Kuishi, Tosa-gun, Tosa-ken, Shikoku, Japan, Dec. 14, 1960, by S. Kurokawa (no. 60154; isotype in US).

Parmelia crenata might at first be mistaken for *P. koyaensis* Asah., but the lobes are consistently smaller and more or less sublinear. It is the only species in section *Hypotrachyna* that contains stictic acid. *Parmelia koyaensis* contains protocetraric acid. Thus far *P. crenata* is known only from the type locality in Japan.

6. *Parmelia croceopustulata* Kurokawa, sp. nov.

PLATE 9

Thallus adnatus, albido-cinereus, ca. 5 cm. diametro, lobis sublinearibus, 1.5–3.5 mm. latis, margine integris, superne nitidus, emaculatus, aetate rugulosus, pustulato-sorediatus, soraliis partim subcoloratis, subtus niger, rhizinosus, rhizinis nigris, ramosis. Apothecia adnata, 1–6 mm. diametro; hymenium 50–60 μ altum; sporae non visae.

Thallus adnate on bark, yellowish glaucous (R), 4–9 cm. in diameter; lobes dichotomously branched, sublinear, 1.5–3.5 mm. wide, 150–220 μ thick, the margins entire to more or less dissected; upper surface shiny, rugulose with age, without maculae, sorediate, the soralia capitate and subterminal, 1–5 mm. in diameter, originating from pustules; medulla below the soralia yellow ochre (R), otherwise white; undersurface black, rhizinate, the rhizines black, shiny, branched. Apothecia rare, adnate, 1–6 mm. in diameter, exciple sorediate, disc chestnut brown (R), radially split; hymenium 50–60 μ high; mature spores not seen.

Reactions: Thallus K+ yellow; medulla K–, C–, KC– or KC+ reddish, P+ orange red or in part P–, soralia P+ orange red, pigment under the soralia K+ purple, atranorine, protocetraric acid, and rhodophyscin present.

Type in Michigan State University, collected on fir around summit of Grandfather Mountain, Avery Co., North Carolina, elev. 5964 ft., June 23, 1958, by H. Imshaug (no. 22275; isotype in US).

Parmelia croceopustulata is related to species in the *P. livida* group, especially *P. formosana* Zahlbr. and *P. leiophylla* Kurokawa, both of which also produce rhodophyscin. *Parmelia formosana* differs in having nonsorediate pustules and lichexanthone. *Parmelia leiophylla*

has similar soorediate pustules but produces olivetoric acid. This species seems to be restricted to higher elevations in Hispaniola and Jamaica, with several interesting disjunct localities in the Appalachian Mountains.

Additional specimens examined: United States: Virginia: White Top Mountain, Washington Co., elev. 5200 ft., *Hale* 18662 (US); North Carolina: Roan Mountain, Avery Co., elev. 6200 ft., *Hale* 18071 (US); Mt. Mitchell, Yancey Co., elev. 6684 ft., *Imshaug* 22383, 22390 (MSC, US); Newfound Gap, Swain Co., *Imshaug* 22435 (MSC, US); Mt. Pisgah, Haywood Co., *Green* in 1959 (US). Dominican Republic: Trail to Alto de la Bandera, Cordillera Central, La Vega, *Imshaug* 23470 (MSC, US). Haiti: Pic La Selle, Morne La Selle, elev. 8844 ft., *Wetmore* 3120 pr. p. (MSC); above Le Refuge, Montagne Noire, Kenscoff, *Imshaug* 22538 (MSC). Jamaica: Mossmans Peak, *Imshaug* 14726 (MSC); High Peak, Blue Mountains, elev. 6800 ft., *Imshaug* 15254 (MSC).

7. *Parmelia degelii* Hale, sp. nov.

PLATE 5

Thallus arcte adnatus, corticola, cinereo-albicans, 4–8 cm. diametro, lobis sublinearibus, 1–2 mm. latis, contiguis, superne rugulosus, isidiis sorediisque destitutus, subtus modice rhizinosus, rhizinis sparse vel modice dichotome ramosis. Apothecia adnata, 3–5 mm. diametro; hymenium 50–60 μ altum; sporae 4–5 \times 8–11 μ .

Thallus closely adnate on bark, 4–8 cm. in diameter, mineral gray; lobes sublinear, 1–2 mm. wide, 140–170 μ thick, contiguous, the margins entire; upper surface dull to more or less shiny, rugulose, transversely rugose with age, isidia and soredia lacking; medulla white; undersurface black, moderately rhizinate, the rhizines sparsely to moderately branched, dichotomous. Apothecia adnate, 3–5 mm. in diameter, the exciple crenate, disc plane; hymenium 50–60 μ high; spores 4–5 \times 8–11 μ .

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ red, P–, atranorine, alectoronic acid, and α -collatolic acid present.

Type in the herbarium of G. Degelius, collected between Luso and Cachipoque, Moxico, Angola, about 1300 m. elevation, Feb. 16, 1960, by G. Degelius (isotype in US).

Parmelia degelii is very close to *P. livida* Tayl. in general habit and color, but *P. livida*, a temperate American lichen with several localities in South Africa, has smaller spores (4–5 \times 6–8 μ), somewhat denser and more richly branched rhizines, and a different chemistry (KC+ red unknown). *Parmelia degelii* is unusual in being the second known species of section *Hypotrachyna* with alectoronic acid in Africa. The other species is *P. exsplendens* Hale, which also occurs in the Caribbean area. The five remaining species in section *Hypotrachyna* with alectoronic acid occur exclusively in tropical America (*P. densirhizinata*

Kurokawa, *P. ensifolia* Kurokawa, *P. gigas* Kurokawa, and *P. lineariloba* Kurokawa) or in Hawaii (*P. cervicornis* Tuck.).

Additional specimens examined: Angola: Same locality and data as the holotype (DEGEL); Rio Kuiriri, near Kassuango, Bie, *Gossweiler* 3256d (BM).

8. *Parmelia densirhizinata* Kurokawa, sp. nov.

PLATE 8

Thallus laxe adnatus, corticola, albido-cinerascens, 6–13 cm. latus, lobis lineari-elongatis, subdivaricatis, 2–6 mm. latis, margine integris, superne planus, emaculatus, pustulato-sorediatus, soraliis subterminalibus, subtus niger, rhizinosus, rhizinis densis, dichotome ramosis. Apothecia ignota.

Thallus loosely adnate on bark, pale glaucous green (R), 6–13 mm. in diameter; lobes dichotomously branched, linear-elongate, subdivaricate, 2–6 mm. wide, 110–150 μ thick, the margins smooth, narrowly black-rimmed; upper surface plane, continuous, without maculae, soresiate, the soralia mainly subterminal, 1–3 mm. in diameter, originating from pustules; medulla white; undersurface black, densely rhizinate, the rhizines black, shiny, dichotomously branched, 1–2 mm. long, projecting in a mat beyond the margins. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ red, P–, atranorine and alectoronic acid present.

Type in the U.S. National Herbarium, collected on the east side of Volcán Chiriquí, Prov. Chiriquí, Panama, elev. 1500–3000 ft., Dec. 5–12, 1948, by P. F. Scholander.

Parmelia densirhizinata is a typical subdivaricate species related to *P. gigas* Kurokawa, a tropical American species, and *P. cervicornis* Tuck., a Hawaiian species. They all produce alectoronic acid, but *P. densirhizinata* is easily distinguished by the subterminal soresiate pustules. It is widespread in tropical America, occurring in mountains between 2000 and 3750 m. elevation.

Additional specimens examined: Guatemala: Pacajá, region of Desconsuelo, Totonicapán, *Standley* 84522 (MO). Panama: Craters edge, Volcán Chiriquí, Prov. Chiriquí, *Scholander*, Dec. 11, 1948 (US). Haiti: Ridge east of Pic La Selle, Morne La Selle, elev. 8300 ft., *Imshaug* 23026 (MSC). Dominican Republic: Trail to Alto de la Bandera Cordillera Central, La Vega, elev. 7200 ft., *Imshaug* 23486 (MSC). Colombia: Páramo de Guasca, Dept. Cundinamarca, *Killip* 34118 (US); Chorreón San Paulina, Nevada del Cocuy, Dept. Boyacá, elev. 3750 m., *Cuatrecasas* 1348a (US). Ecuador: Mount Tunguragua, *Spruce* 175 (K). Peru: Pampalca, Dept. Ayacucho, elev. 3200 m., *Killip & Smith* 22237 (US). Bolivia: Unduavi Valley, *Julio* 413 (US). Chile: Isla de Chiloe, *Joseph* 2245 (US); Cerro Tralcan, Lago Rinihue,

Prov. Valdivia, *Santesson* 3451 (S); Canal Whiteside, Puerto Yartou, Tierra del Fuego, *Santesson* 6799 (S).

9. *Parmelia dentella* Hale & Kurokawa, sp. nov.

PLATE 5

Thallus laxe adnatus, saxicola, viridi-cinerascens, 3–8 cm. diametro, lobis sublinearibus vel subirregularibus, subimbricatis, 2–6 mm. latis, margine dentato-crenatis, superne planus, albomaculatus, dense isidiatus, subtus nigricans, sparse vel modice rhizinosus, rhizinis nigris, ramosis. Apothecia ignota.

Thallus loosely adnate on shaded rocks, yellowish glaucous to glaucous green (R), 3–8 cm. in diameter; lobes irregularly branched, sublinear to subirregular, more or less imbricate, 2–6 mm. wide, 150–230 μ thick, the margins in part dentate-crenate; upper surface plane, distinctly white-maculate, densely isidiate, the isidia often branched, cylindrical, less than 0.7 mm. high; medulla white; under-surface black, pale brown in a rather broad zone at the tips, sparsely to moderately rhizinate, the rhizines black, shiny, moderately branched, about 1 mm. long. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellowish, C–, KC–, P+ pale orange red, atranorine and an unknown P+ substance present.

Type in the U.S. National Herbarium, collected on granite at Cheaha State Park, Clay County, Alabama, Mar. 16, 1962, by H. McCullough (no. 570; isotypes in TNS and the herbarium of Howard College, Birmingham, Alabama).

Parmelia dentella bears a striking resemblance to the endemic Japanese species *P. crenata* Kurokawa. It differs from *P. crenata* in having the upper cortex distinctly white-maculate and in producing a P+ unknown substance instead of stictic acid. It also resembles *P. costaricensis* Nyl., especially in the maculae, isidia, and size of the thallus, but the rhizines of *P. costaricensis* are much more densely branched and its main component is caperatic acid (P–). *Parmelia dentella* is still known only from the type locality in Alabama, a rather dry oak forest rich in many kinds of lichens. It will probably be found again in the foothills of the Appalachian Mountains.

10. *Parmelia ensifolia* Kurokawa, sp. nov.

PLATE 7

Thallus adnatus, albido-cinerascens, 5–11 cm. latus, lobis sublinearibus, 1–4 mm. latis, margine lobulatis, superne nitidus, emaculatus, isidiato-lobulatus, subtus niger, rhizinosus, rhizinis nigris, dichotome ramosis. Apothecia adnata, 3–4 mm. diametro; hymenium 50–65 μ altum; sporae 8–10 \times 14–18 μ .

Thallus loosely adnate, corticolous, pearl gray (R), 5–11 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 1–4 mm. wide, 160–200 μ thick, the margins with numerous lobules, the lobules

ascending, dorsiventral, short-rhizinate below, often branched, up to 1.5 mm. long; upper surface shiny, without maculae, short-isidiate-lobulate to lobulate on the margins; medulla white; undersurface black, densely rhizinate, the rhizines black, shiny, dichotomously branched. Apothecia adnate, 3–4 mm. in diameter, disc tawny olive (R), amphithecium rugose; hymenium 50–65 μ high; spores 8–10 \times 14–18 μ .

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ rose or red, P–, atranorine and alectoronic acid present.

Type in Michigan State University, collected in pine forest below summit of Alto de la Bandera, Cordillera Central, La Vega, Dominican Republic, elev. 8300 ft., Aug. 5, 1958, by H. Imshaug (no. 23430; isotype in US).

Parmelia ensifolia has sublinear lobes and laminal and marginal lobules similar to those of *P. culmigena* Zahlbr. and *P. digitata* Lynge. The latter two species, however, are distinctly maculate and differ chemically, *P. culmigena* having evernic acid and *P. digitata* having barbatic acid. *Parmelia ensifolia* is distinguished by the presence of alectoronic acid and lack of maculae. It seems to be rather common in tropical America.

Additional specimens examined: Mexico: No data on locality, 1890 (S). Panama: Volcán Chiriquí, Prov. Chiriquí, *Scholander*, Dec. 5–12, 1948 (MO, US). Jamaica: Summit of Blue Mountain Peak, *Maxon* 9865 (US). Haiti: Pic La Selle, Morne La Selle, *Wetmore* 3086 (MSC, US). Dominican Republic: Below summit of Alto de la Bandera, Cordillera Central, La Vega, elev. 8300 ft., *Wetmore* 3511 (MSC, US). Venezuela: Pan de Azúcar, Mérida, *Jahn* 241 (US); Laguna de Canoa, Sierra de Santo Domingo, Mérida, *Dennis* 1924, 1950 (K).

11. *Parmelia erythrodes* (Zahlbr.) Hale & Kurokawa, comb. nov.

Parmelia brasiliiana Nyl. var. *erythrodes* Zahlbr. Denkschr. Akad. Wiss. Wien Math. Naturw. 83: 169. 1927. Type collection: Mt. Itatiaya, Minas Gerais, Brazil, *Schiffner*, September 1901 (WU, holotype).

Thallus adnate on rock, ivory yellow, deep mouse gray towards the center, about 5 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 1–2 mm. wide, 140–190 μ thick, the margins entire to subcrenate; upper surface plane, shiny, emaculate, tangentially cracked on older lobes, isidia and soredia lacking; medulla pale pinkish buff in the lower half, white above; undersurface uniformly black, moderately rhizinate, the rhizines black, moderately branched, 0.5–1.0 mm. long. Apothecia adnate, 2–6 mm. in diameter, exciple undulate, disc imperforate, blackish brown; hymenium 50–60 μ high; spores 5–6 \times 9–10 μ , episporium 1 μ thick.

Reactions: Thallus K+ yellow; medulla K-, C-, KC+ rose, P-, pigment K+ reddish purple, atranorine, a KC+ unknown (apparently the same as the one in *P. livida* Tayl.), rhodophyscin, and lichexanthone.

Parmelia erythrodes is very close to *P. brasiliiana* Nyl., differing chiefly in chemistry. *Parmelia brasiliiana* lacks rhodophyscin and the KC+ substance but contains lichexanthone and in addition protocetraric acid. Both species are typically saxicolous and occur rather rarely in South America.

Additional specimen examined: Peru: Without locality, *Lobb* s.n. (BM).

12. *Parmelia exporrecta* Kurokawa, sp. nov.

PLATE 6

Thallus laxe adnatus, albido-cinereascens, 7-10 cm. latus, lobis lineari-elongatis, subdivaricatis, 2-6 mm. latis, superne planus, nitidus, emaculatus, sorediis isidiisque destitutus, subtus niger, rhizinosus, rhizinis nigris, dense ramosis. Apothecia ignota.

Thallus loosely adnate on bark, pale glaucous green (R), 7-10 cm. in diameter; lobes dichotomously branched, linear-elongate, subdivaricate, 2-6 mm. wide, 150-220 μ thick, the margins smooth, rarely lobulate; upper surface plane and smooth, shiny, often pruinose near the tips, without maculae, isidia or soredia; medulla white; under-surface black, rhizinate, the rhizines black, shiny, densely branched, about 1 mm. long. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K-, C+ rose, KC+ red, P-, atranorine and gyrophoric acid present.

Type in the United States National Herbarium, collected in mature pine-oak forest, on trail leading to Cerro San Felipe, Oaxaca, Mexico, elev. about 3000 m., Apr. 1, 1960, by M. E. Hale (no. 20722).

Parmelia exporrecta seems to be the nonsorediate ally of *P. thysanota* Kurokawa (see below). It has a large subdivaricate thallus and linear-elongate lobes, much as in *P. gigas* Kurokawa, which differs in containing alectoronic acid.

Additional specimen examined: Mexico: Vera Cruz: Orizaba, *Liebmann* 116 (UPS).

13. *Parmelia exsplendens* Hale, sp. nov.

Thallus adnatus, viridi-vel cinereo-albicans, 4-8 cm. diametro, lobis sublinearibus, 1.5-2.5 mm. latis, superne nitidus, valde albomaculatus, sorediatus, soralis subterminalibus, subtus niger, dense rhizinosus, rhizinis dichotome ramosis. Apothecia ignota.

Thallus adnate, greenish to whitish gray, 4-8 cm. across, corticolous; lobes sublinear, dichotomously branched, 1.5-2.5 mm. wide, 160-200 μ thick, the margins entire to subcrenate; upper surface plane, shiny, strongly white-maculate, sorediate, soralia capitate,

subterminal; medulla white; undersurface black, densely rhizinate, the rhizines black, dichotomously branched. Apothecia unknown.

Reactions: Thallus K+ yellow; medulla K-, C-, KC+ red, P-, atranorine and alectoronic acid present.

Type in Michigan State University, collected on ridge northwest of Murdock's Gap, Blue Mountains, Jamaica, elev. 3600 ft., Mar. 19, 1953, by H. Imshaug (no. 15306; isotype in US).

This species resembles *P. metarevoluta* Asah. from Asia in having a medium-sized thallus and subterminal capitate soralia. However, it is distinctly white-maculate and the rhizines are densely branched. *Parmelia exsplendens* is fairly common in the Caribbean with one disjunct record from South Africa.

Additional specimens examined: Mexico: Virgin upland jungle, El Suspiro, Chiapas, *Hale* 20229 (US). Guatemala: Near Tactic, Alta Verapaz, *Standley* s.n. (MO, no. 185561). Jamaica: Gap southeast of Catherine's Peak, *Imshaug* 13894 (MSC); gap on northeast spur of High Peak, *Imshaug* 15287 (MSC); Woodcutters Gap, *Imshaug* 13423 (MSC, US); Summit, Blue Mountains, *Imshaug* 13855 (MSC); west slope of John Crow Mountains, above Corn Puss Gap, *Imshaug* 14577 (MSC). Union of South Africa: 5 mi. east of Mokobulaan, Lydenberg, Transvaal, *Almborn* 7496 (LD).

14. *Parmelia fissicarpa* Kurokawa, sp. nov.

PLATE 7

Thallus adnatus vel laxe adnatus, albido-cinerascens, ca. 14 cm. diametro, lobis sublinearibus vel subirregularibus, 2-4 mm. latis, margine subcrenatis superne nitidulus, emaculatus, isidiis sorediisque destitutus, subtus niger, dense rhizinosus, rhizinis nigris, ramosis. Apothecia substipitata, ca. 10 mm. diametro; hymenium 60-70 μ altum; sporae 6-7 \times 8-10 μ .

Thallus adnate to loosely attached on rock, pale olive buff (R), about 14 cm. in diameter; lobes irregularly branched, sublinear to subirregular, 2-4 mm. wide, 210-250 μ thick, the margins subcrenate; upper surface rather shiny, without maculae, the older lobes rugulose, isidia and soredia lacking; medulla white; undersurface black, densely rhizinate, the rhizines black, shiny, moderately branched, often more than 1.5 mm. long. Apothecia substipitate, 10 mm. or more in diameter, exciple undulate, amphithecium rugose, disc carob brown (R), radially split; hymenium 60-70 μ high; spores 6-7 \times 8-10 μ .

Reactions: Thallus K+ yellow; medulla K-, C-, KC+ faint red, P+ orange red, atranorine and protocetraric acid present.

Type in the Botanical Museum, Lund University, collected 2 miles south of forester's office, Cathedral Peak Area, Bergville, Natal, Union of South Africa, Nov. 7, 1953, by Ove Almborn (no. 9374; isotype in US).

This peculiar species has an exceptionally large thallus and apothecia. It resembles *P. insinuans* Nyl., a tropical American species, and *P. keitauensis* Asah. and *P. manilensis* Vain., both Asian species, in having rather irregularly branched lobes and protocetraric acid. Although *P. fissicarpa* and *P. insinuans* have similar spore size, the thallus of *P. fissicarpa* is much larger and the rhizines are longer. In addition, *P. insinuans* often produces the pigment rhodophyscin along with protocetraric acid. *Parmelia fissicarpa* is clearly distinguished from *P. keitauensis* by the absence of fatty acids and by smaller spores. *Parmelia manilensis* differs in having adnate and quite small apothecia (1–3 mm. in diameter) and large spores.

15. *Parmelia flavovirens* Kurokawa, sp. nov.

PLATE 8

Thallus adnatus, corticola, viridiflavicans, 3–6 cm. diametro, lobis sublinearibus, 1.0–2.5 mm. latis, margine subcrenatis, superne nitidus, aetate rugulosus, centrum versus lobulatus, sorediatus, soraliis subterminalibus, subtus niger, dense rhizinosus, rhizinis nigris, ramosis. Apothecia adnata, 2–4 mm. diametro; hymenium 60–75 μ altum; sporae 7–10 \times 11–15 μ .

Thallus adnate on bark, sea-foam green (R), 3–6 cm. in diameter; lobes more or less irregularly branched, sublinear, 1.0–2.5 mm. wide, 130–150 μ thick, the margins more or less crenate, often narrowly black-rimmed; upper surface shiny near the tips, more or less rugulose and irregularly cracked on older lobes, sometimes lobulate toward the center, sorediate, soralia mainly subterminal; medulla white; under-surface black, densely rhizinate, the rhizines black, branched. Apothecia adnate, 2–4 mm. in diameter, exciple crenate, amphithecium rugose, disc light seal brown (R); hymenium 60–75 μ high; spores 7–10 \times 11–15 μ .

Reactions: Thallus K+ yellowish; medulla K–, C–, KC+ faint red, P+ deep orange red, usnic acid, and protocetraric acid present.

Type in the Naturhistoriska Riksmuseet, Stockholm, collected near Hotel Rio Rubens, 50 km. southeast of Natales, Magallanes, Chile, Jan. 14, 1941, by R. Santesson (no. 5681; isotype in US).

Parmelia flavovirens is very close in external appearance to *P. sinuosa* (Sm.) Ach. and *P. velloziae* Vain. The last named species has similar chemistry but contains in addition the orange-red pigment rhodophyscin under the soralia. *Parmelia sinuosa* produces salacinic acid. *Parmelia flavovirens* is apparently endemic to southernmost Chile where it occurs intermingled with *P. sinuosa*.

Additional specimens examined: Chile: Puerto Navarino, Isla Navarino, Tierra del Fuego, Santesson 1261 (S); Aysén: Coyhaigue, Santesson 8406 (S).

16. *Parmelia gigas* Kurokawa, sp. nov.

PLATE 8

Thallus laxe adnatus, corticola, albido-cinereascens, 15–40 cm. diametro, lobis lineari-elongatis, subdivaricatis, 3–10 mm. latis, margine integris, superne planus, emaculatus, isidiis sorediisque destitutus, subtus niger, breve rhizinosus, rhizinis nigris, dense ramosis. Apothecia usque ad 15 cm. diametro, substipitata; hymenium 50–65 μ altum; sporae 8–10 \times 16–18 μ .

Thallus loosely attached on bark, mosses, or humus, turning from ivory yellow to cream buff (R) in the herbarium, 15–40 cm. in diameter; lobes dichotomously branched, linear-elongate, subdivaricate and separate, 3–10 mm. wide, 220–330 μ thick, the margins smooth, rarely short lobulate; upper surface plane and smooth, shiny, without maculae, isidia and soredia lacking; medulla white; undersurface black, short rhizinate, partly naked, the rhizines black, shiny, densely branched, about 1 mm. long, forming a mat projecting narrowly beyond the margins. Apothecia rare, to 15 mm. in diameter, substipitate, amphithecium strongly rugose, faintly maculate; hymenium 50–65 μ high; spores 8–10 \times 16–18 μ , the episporium 1.5 μ thick.

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ red, P–, atranorine and alectoronic acid present.

Type in the United States National Herbarium, collected at Laguna Verjou, above Bogotá, Colombia, 1922, by Ariste Joseph (no. B70; isotypes in DUKE, REN, S, TNS).

This species has a large divaricate thallus, long linear-elongate lobes, and densely branched, short rhizines. Externally it is very similar to and has been misidentified as *P. caraccensis* Tayl., which differs significantly in producing usnic and norstictic acids. It is also related to the Hawaiian species *P. cervicornis* Tuck. in that it produces the same chemical substances. The thallus of *P. gigas*, however, is much larger and the lobes ordinarily wider than in *P. cervicornis*. The rhizines of *P. gigas*, furthermore, are short, usually about 1 mm. long, and form a dense mat on the lower side, whereas the rhizines of *P. cervicornis* are often more than 2 mm. long and relatively sparse. *Parmelia gigas* is widely distributed in tropical America, being especially common at higher elevations (up to 3900 m.) in cloud forests.

Additional specimens examined: Mexico: Oaxaca: Trail leading to Cerro san Felipe, elev. 2920–3000 m., Hale 20707, 20723, 20783, 21100 (US). Panama: Craters edge, Volcán Chiriquí, Prov. Chiriquí, Scholander, Dec. 12, 1948 (MO). Venezuela: Pan de Azúcar, Cordillera de Mérida, elev. 4000 m., Jahn 240 (US). Colombia: Carrizales, north of Las Brisas, Cordillera Occidental, Dept. Valle, Cuatrecasas 20545 (US); eastern slope of Páramo de las Coloradas, Dept. Santander, elev. 3300–3900 m., Killip & Smith 18394, 18481 (US); Los Gaques,

western slope of Páramo de Guasca, Dept. Cundinamarca, elev. 3250 m., *Killip* 34064B (US); without locality: *Lindig* 2573 (UPS). Ecuador: Páramo de Minza Chica, Tunguragua, elev. 3800 m., *Penland* 404 (MO, US); Páramo de Volcán Cayambe, Dept. Pichincha, elev. 13,000 ft., *Prescott* (MSC, US).

17. *Parmelia immaculata* Kurokawa, sp. nov.

Thallus adnatus, corticola, albido-cinerascens, 4–9 cm. latus, lobis sublinearibus, contiguus, 1–3 mm. latis, superne nitidulus, aetate rugosulus, sorediatus, soraliis laminalibus, subtus sparse rhizinosus, rhizinis nigris, brevibus, dichotome ramosis. Apothecia rara, substipitata, 1.5–4.5 mm. diametro; hymenium 50–60 μ altum; sporae 5–7 \times 9–10 μ .

Thallus adnate on bark, yellowish glaucous (R), 4–9 cm. across; lobes dichotomously branched, sublinear-elongate, contiguous, 1–3 mm. wide, 110–200 μ thick, the margins smooth or sparsely lobulate with age; upper surface rather shiny, plane, becoming rugulose and irregularly cracked on older lobes, soresiate, the soralia orbicular, laminal, often fusing; medulla white; undersurface sparsely rhizinate, minutely rugulose, black, the rhizines black, short, dichotomously branched. Apothecia more or less stipitate, 1.5–4.5 mm. in diameter, exciple crenate, amphithecium soresiate, disc vandyke brown (R), radially split; hymenium 50–60 μ high; spores 5–7 \times 9–10 μ .

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ rose, P–, pigment if present K+ purple, atranorine, KC+ unknown, and rhodophyscin present.

Type in the Botanical Museum, Lund University, collected at Punch Bowl Inn, north of Louis Trichardt, Zoutpansberg, Transvaal, Union of South Africa, Oct. 11, 1953, by Ove Alborn (no. 6551; isotype in US).

Parmelia immaculata belongs to that group of species near *P. dactylifera* Vain. and *P. livida* Tayl., all of which contain the same unknown KC+ substance. *Parmelia dactylifera* is pustulate-isidiate, whereas *P. livida* lacks pustules and soredia. *Parmelia immaculata* is apparently a very common corticolous lichen in South Africa, occurring frequently with *P. leiophylla* Kurokawa. A single specimen from Java also seems to belong to this species.

Additional specimens examined: Africa: South of Felixburg, Southern Rhodesia, *Höeg*, April 2, 1930 (TRH); Punch Bowl Inn, north of Louis Trichardt, Zoutpansberg, Transvaal, *Alborn* 6440, 6550 (LD), 6247 (LD, US); Polela Forest, Polela, Natal, *Alborn* 9511 (LD, US); Stormsrivier, Humansdorp, *Alborn* 4132 (LD); Grootvadersbosch, Swellendam, Cape Province, *Alborn* 2194, 2195, 2196 (LD); Grahams-town, Albany, Cape Province, *Höeg*, December 1929 (TRH). Java: Tjibodas, *Neervoort* 3140 (BO).

18. *Parmelia infirma* Kurokawa, sp. nov.

PLATE 7

Thallus laxe adnatus, corticola, olivaceo-albicans, 3–8 cm. diametro, lobis sublinearibus, subimbricatis, 1.0–3.5 mm. latis, margine subcrenatis, superne nitidus, emaculatus, isidiatus, subtus niger, breviter rhizinosus, rhizinis nigris, ramosis. Apothecia adnata, 1.0–2.5 mm. diametro; hymenium 60–85 μ altum; sporae 9–13 \times 15–19 μ .

Thallus loosely adnate on bark, yellowish glaucous (R), 3–8 cm. across; lobes irregularly branched, sublinear, sometimes imbricate, 1.0–3.5 mm. wide, 130–170 μ thick, the margins more or less crenate, sometimes blackrimmed; upper surface shiny, without maculae, isidiate, the isidia cylindrical, moderate, simple to coralloid branched; medulla white; undersurface black, short-rhizinate, the rhizines black, shiny, branched. Apothecia adnate, 1.0–2.5 mm. in diameter, exciple entire, amphithecium usually isidiate, disc seal brown (R); hymenium 60–85 μ high; spores 9–13 \times 15–19 μ .

Reactions: Thallus K+ yellow; medulla K–, C–, KC–, P–, atranorine, caperatic and protolichestic acids present.

Type in the National Science Museum, Tokyo, collected at Darjeeling, Kurseong, India, Apr. 12, 1960, by H. Hara et al. (isotype in US).

This new species resembles *P. koyaensis* Asah. in external appearance, spore size, and presence of fatty acids. The isidia of *P. infirma* are shorter and sometimes become more or less granular. *Parmelia koyaensis* is P+ red, containing protocetraric acid, which has not been demonstrated in *P. infirma*. The related isidiate species *P. nodakensis* Asah. is KC+ rose and *P. crenata* Kurokawa contains stictic acid (K+ yellow). *Parmelia infirma* also resembles the tropical American species *P. costaricensis* Nyl., which is distinctly maculate. *Parmelia infirma* is known only from the type locality.

19. *Parmelia leiophylla* Kurokawa, sp. nov.

PLATE 9

Thallus adnatus, corticola, cinereo-albicans, 3–7 cm. diametro, lobis sublinearibus, contiguis, 1–3 mm. latis, superne planus, nitidulus, aetate rugosus, pustulatus, medulla pro parte ochracea, subtus niger, rhizinosus, rhizinis nigris, dichotome ramosis. Apothecia rara, adnata, usque ad 1 cm. diametro; hymenium 50–55 μ altum; sporae 5–6 \times 10–13 μ .

Thallus adnate, corticolous, yellowish glaucous (R), 3–7 cm. across; lobes dichotomously branched, sublinear, contiguous, 1–3 mm. wide, 130–180 μ thick, the margins smooth; upper surface plane, rather shiny, rugulose on older lobes, pustulate, not distinctly soerediate, without maculae; medulla white, turning yellow ochre (R) under the pustules; undersurface black, rhizinate, the rhizines black, shiny, dichotomously branched, rarely projecting beyond the margins. Apothecia very

rare, adnate, to 1 cm. in diameter, amphithecium rugose, disc split with age, rarely abnormally perforate; hymenium 50–55 μ high; spores 5–6 \times 10–13 μ .

Reactions: Thallus K+ yellow; medulla K–, C+ deep red, KC+ red, P–, pigment K+ purple, atranorine, olivetoric acid, and rhodophyscin present.

Type in the Botanical Museum, Lund University, collected on Forest Drive from Houtbosch to Tzaneen, Pietersburg, Transvaal, Union of South Africa, Oct. 12, 1953, by Ove Almborn (no. 6796; isotype in US).

This species resembles *P. livida* Tayl. in general habitus but is separated by the sorediate pustules and chemistry. *Parmelia immaculata* Kurokawa, which has similar distribution in South Africa, is distinctly sorediate and C–, KC+ rose. *Parmelia formosana* Zahlbr. is strictly pustulate and contains lichexanthone. The American species *P. croceopustulata* Kurokawa has similar coarsely sorediate pustules and rhodophyscin, but the main component is protocetraric acid (C–, P+ red).

Additional specimens examined: Union of South Africa: Transvaal: Punch Bowl Inn, north of Louis Trichardt, Zoutpansberg, *Almborn* 6435 (LD); Natal: South of Nkandhla, Nkandhla, *Almborn* 8074 (LD), Impetyne Forest near Weza, Alfred, *Almborn* 9969 (LD), Indumeni Forest, Cathedral Peak Area, Bergville, *Almborn* 9191 (LD); Cape Province: Deepwall Forest, Knysna, *Arnell* 1632a, 1645 (LD), Table Mountain, *Arnell* 861 (LD), *Maas Geesteranus* 12167 (L), along Skeleton Stream, east slopes of Table Mountain, Wynberg, *Almborn* 11153 (LD), Fern Kloof, Albany, *Almborn* 10735 (LD).

20. *Parmelia lineariloba* Kurokawa, sp. nov.

PLATE 6

Thallus adnatus, corticola, cinereo-albicans, 3–5 cm. diametro, lobis sublinearibus, elongatis, subdivaricatis, separatis, 0.5–2.0 mm. latis, superne planus, nitidus, emaculatus, isidiis sorediisque destitutus, subtus niger, rhizinosus, rhizinis longis, nigris, sparse ramosis. Apothecia ignota.

Thallus adnate on bark, pale gull grey (R), 3–5 cm. in diameter; lobes dichotomously branched, linear-elongate, subdivaricate, separate, 0.5–2.0 mm. wide, 100–130 μ thick, the margins smooth, narrowly black-rimmed; upper surface plane and smooth, shiny, without maculae, isidia and soredia lacking; medulla white; undersurface black, rhizinate, the rhizines black, long and sparsely branched, about 1 mm. long. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ red, P–, atranorine and alectoronic acid present.

Type in Michigan State University, collected in pine forest at summit of Alto de la Bandera, Cordillera Central, La Vega, Dominican Republic, elev. 2800 m., Aug. 5, 1958, by C. Wetmore (no. 3475; isotype in US).

Parmelia lineariloba has sublinear lobes that are quite narrow, long, and usually subdivaricate. The rhizines are rather long and only moderately branched. The chemically related subdivaricate species *P. gigas* Kurokawa and *P. cervicornis* Tuck. are much larger in size. *Parmelia lineariloba* is at present known only from the Dominican Republic, where it is found at high elevations in pine forests. We might expect it to be common in similar habitats elsewhere in the West Indies.

Additional specimens examined: Dominican Republic: Ridge connecting La Rucilla and Pico Trujillo, Macisco Central, elev. 8000 ft., Wetmore 3599, 3628 (MSC, US).

21. *Parmelia lividescens* Kurokawa, sp. nov.

Thallus adnatus, corticola, cinereo-albicans, 5–10 cm. diametro, lobis sublinearibus, 1.5–3.0 mm. latis, margine subcrenatis, superne nitidulus, sorediatus, soraliis subterminalibus, subtus sparse rhizinosus, niger, rhizinis nigris, dichotome ramosis. Apothecia adnata, 2–3 mm. diametro; hymenium 40–50 μ altum; sporae 5–7 \times 9–11 μ .

Thallus adnate on bark, yellowish glaucous (R), 5–10 cm. across; lobes dichotomously branched, sublinear, separate at the circumference, 1.5–3.0 mm. wide, 140–180 μ thick, the margins subcrenate; upper surface shiny on younger lobes, dull and irregularly cracked on older lobes, soresiate, soralia orbicular, laminal and subterminal; medulla white; undersurface sparsely rhizinate, black, the rhizines black, dichotomously branched. Apothecia adnate, 2–3 mm. in diameter, disc saccardo's brown (R), radially split; hymenium 40–50 μ high; spores 5–7 \times 9–11 μ .

Reactions: Thallus K+ yellow; medulla K–, C+ red, KC+ red, P–, atranorine and olivetoric acid present.

Type in the Botanical Museum, Lund University, collected on bark, Polela Forest, Polela, Natal, Union of South Africa, Nov. 10, 1953, by Ove Alborn (no. 9490; isotype in US).

This species resembles *P. revoluta* Flk. in the presence of subterminal capitate soralia and in the absence of maculae. *Parmelia revoluta*, however, produces gyrophoric acid and has more sparsely branched rhizines. *Parmelia leiophylla* Kurokawa has the same chemical content as *P. lividescens* but differs in having laminal soresiate pustules.

Additional specimen examined: Union of South Africa: 6 mi. north of Knysna, Knysna, Cape Province, Alborn 2665 (LD).

22. *Parmelia monilifera* Kurokawa, sp. nov.

PLATE 9

Thallus adnatus, corticola, cinereo-albicans, ca. 12 cm. diametro, lobis sublineari-elongatis, subdivaricatis, 2–6 mm. latis, superne planus, nitidus, emaculatus, isidiis soredisque destitutus, subtus niger, dense rhizinosus, rhizinis nigris, ramosis, saepe moniliformibus. Apothecia ignota.

Thallus loosely adnate on bark, grayish white, about 12 cm. in diameter; lobes dichotomously branched, sublinear-elongate, subdivaricate, 2–6 mm. wide, 200–250 μ thick, the margins smooth; upper surface smooth, plane to concave, shiny, without maculae, isidia and soredia lacking; medulla white; undersurface black, densely rhizinate, the rhizines black, shiny, branched, often moniliform or opuntoid, projecting as a mat beyond the margins. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K–, C– or C+ pale orange, KC+ deep orange red, P–, atranorine, barbatic acid, and an unknown KC+ substance present.

Type in the Botanische Staatssammlung, Munich, collected at La Aguada, Mérida, Venezuela, Apr. 2, 1958, by K. Mägdefrau (no. 651; isotype in US).

This species resembles *P. gigas* Kurokawa, *P. cervicornis* Tuck., and *P. exporrecta* Kurokawa in having a large divaricate thallus and sublinear-elongate lobes. It is clearly separated by the coarse, branched, moniliform or opuntoid rhizines, a type that we have not seen in any other species of *Parmelia*. It is especially distinct chemically, since related species have alectoronic acid, or less commonly gyrophoric acid. The species is known only from the type locality in Venezuela.

23. *Parmelia prolongata* Kurokawa, sp. nov.

PLATE 6

Thallus laxe adnatus, corticola, olivaceo-albicans, 5–10 cm. diametro, lobis sublinearibus, 1.5–4.0 mm. latis, margine partim isidiato-dissectis, superne planus, nitidus, exigue albomaculatus, sparse isidiatus, medulla alba vel pallide flavescens, subtus niger, dense rhizinosus, rhizinis nigris, dense ramosis. Apothecia ignota.

Thallus loosely adnate on bark, sea-foam yellow (R) turning olive buff in the herbarium, 5–10 cm. across; lobes dichotomously branched, sublinear, elongate, sometimes subimbricate, 1.5–4.0 mm. wide, 100–200 μ thick, the margins smooth or in part with isidial branchlets or isidia, often elongate, ascending or suberect, dorsiventral or becoming cylindrical and coralloid branched; upper surface plane and smooth, weakly maculate, rather shiny, often sparsely isidiate, the isidia cylindrical, variable, sometimes branched; medulla white to cartridge buff (R); undersurface black, densely rhizinate, the

rhizines black, shiny, densely branched, often forming a mat. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K—, C+ deep red, KC+ red, P—, atranorine, a C+ unknown substance, and frequently a pale-yellowish pigment present.

Type in Michigan State University, collected on ridge leading to Pic Macaya, Morne Macaya, Dept. du Sud, Haiti, elev. 6400–7000 ft., July 27, 1958, by C. Wetmore (no. 3233; isotype in US).

Parmelia prolongata is characterized by peculiar laminal and marginal isidia which are cylindrical at first but which at length become dorsiventral, suberect, and more or less branched, and as much as 5 mm. long. However, the production of isidia and lobules is extremely variable and they may be reduced to small marginal isidia. All specimens have in common a deep C+ reaction caused by an unknown substance apparently related to olivetoric or anziaic acid. The pale-yellow pigment may or may not be clearly present and its identity is unknown. *Parmelia prolongata* is found at higher elevations, often on conifer bark, in the Caribbean and Andean regions.

Additional specimens examined: Mexico: Chiapas: 18 km. southeast of San Cristóbal, *Hale* 20286 (US). Panama: Prov. Chiriquí: East side of Volcán Chiriquí, *Scholander*, Dec. 5–12, 1948 (US). Haiti: Ridge leading to Pic Macaya, Morne Macaya, Dept. du Sud, elev. 6400–7000 ft., *Wetmore* 3233 (MSC, US), 3286 (MSC). Colombia: Western slopes of Páramo de Cruz Verde, Dept. Cundinamarca, 3150 m., *Cuatrecasas* 450Z (US).

24. *Parmelia rhabdiformis* Kurokawa, sp. nov.

Thallus adnatus, corticola, olivaceo-albicans in herbario, ca. 8 cm. diametro, lobis sublinearibus, 2–6 mm. latis, subimbricatis, margine plus minusve dissectis, superne planus, nitidus, emaculatus, isidiatus, subtus niger, dense rhizinosus, rhizinis nigris, dense ramosis. Apothecia adnata, 1–5 mm. diametro; hymenium 60–80 μ altum; sporae 6–8 \times 15–21 μ .

Thallus adnate on bark, turning cream buff (R) in the herbarium, about 8 cm. in diameter; lobes irregularly branched, sublinear, 2–6 mm. wide, subimbricate, 150–200 μ thick, the margins more or less dissected; upper surface plane, shiny, without maculae, isidiate, the isidia mostly simple, club-shaped, about 0.5 mm. high; medulla white; undersurface black, densely rhizinate, the rhizines black, densely and finely branched, forming a woolly mat. Apothecia adnate, 1–5 mm. in diameter, exciple crenate, amphithecium isidiate, disc sayal brown (R), sometimes radially split; hymenium 60–80 μ high; spores 6–8 \times 15–21 μ .

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C—, KC—, P+ pale orange red, atranorine and norstictic acid present.

Type in the U.S. National Herbarium, collected in the vicinity of El Boquete, Prov. Chiriquí, Panama, Mar. 2, 1911, by W. R. Maxon (no. 5128a).

Except for the production of norstictic acid, this species resembles *P. infirma* Kurokawa and *P. crenata* Kurokawa, both Asian species. The isidia of *P. rhabdiformis* are mostly simple and clavate and rather elongate, to 0.5 mm. high. It is known only from the type locality in Panama.

25. *Parmelia rigidula* Kurokawa, sp. nov.

Thallus adnatus, corticola, olivaceo-cinerascens, 7–12 cm. diametro, lobis sublinearibus vel subirregularibus, subimbricatis, usque ad 7 mm. latis, margine subcrenatis, superne nitidulus, exigue albomaculatus vel emaculatus, sorediis isidiisque destitutus, medulla pallide flavicans, subtus niger, rhizinosus, rhizinis nigris, modice ramosis. Apothecia adnata, 2–7 mm. diametro; hymenium 70–85 μ altum; sporae 10–12 \times 15–18 μ .

Thallus adnate on bark, pale olive buff (R), 7–12 cm. in diameter; lobes irregularly branched, sublinear to subirregular, more or less imbricate, up to 7 mm. wide, 210–250 μ thick, the margins crenate, often narrowly black-rimmed; upper surface plane to concave, more or less shiny, weakly maculate or without maculae; medulla sea-foam yellow to pale-pinkish buff (R), K—; under surface black, moderately rhizinate, the rhizines black, matted, sparsely to moderately branched. Apothecia adnate, 2–7 mm. diameter, exciple smooth to undulate, disc dark livid-brown (R), sometimes radially split; hymenium 70–85 μ high; spores 10–12 \times 15–18 μ .

Reactions: Thallus K+ yellow; medulla K—, C—, KC—, P—, atranorine and a pale-yellow pigment present.

Type in the National Science Museum, Tokyo, collected at Phalut, Darjeeling, India, June 6, 1960, by H. Hara (isotype in US).

This species has a peculiar coriaceous thallus as in *P. scytodes* Kurokawa and *P. scytophylla* Kurokawa. However, it is distinguished by producing a pale-yellow-orange pigment in the medulla (apparently not entothecin). Superficially it resembles *P. subaurulenta* Nyl., but the rhizines are sparsely to moderately branched, not simple. Only two specimens have been collected, both in northern India, where it is endemic.

Additional specimen examined: India: Tongloo, Himalayas, Watt 7035 (BM).

26. *Parmelia scytodes* Kurokawa, sp. nov.

PLATE 6

Thallus adnatus vel laxe adnatus, corticola, cinereo-albicans, ca. 20 cm. diametro, lobis sublinearibus, 2–5 mm. latis, superne planus, emaculatus, isidiis sorediisque destitutus, subtus niger, dense rhizinosus, rhizinis nigris, modice ramosis. Apothecia ignota.

Thallus adnate to loosely adnate on bark, rather coriaceous, pale smoke gray (R), about 20 cm. across; lobes irregularly branched, sublinear, 2–5 mm. wide, 150–200 μ thick, the margins subcrenate, narrowly black-rimmed; upper surface plane and smooth, becoming rugose on older lobes, without maculae, isidia and soredia lacking; medulla white; undersurface black, moderately to densely rhizinate, the rhizines black, shiny, moderately branched. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ orange, P+ orange red, atranorine, barbatic acid, and an unidentified P+ acid present.

Type in the National Science Museum, Tokyo, collected at Darjeeling, Batasi, India, May 6, 1960, by Togashi (isotype in US).

This new species is characterized by the large rather coriaceous thallus. Externally it resembles *P. fissicarpa* Kurokawa, an African species with a P+ reaction but no barbatic acid. *Parmelia bostrychodes* Zahlbr. and *P. physcioides* Nyl., both of which produce barbatic acid without a P+ substance, have smaller sublinear lobes. *Parmelia scytodes* is known only from the type locality in India.

27. *Parmelia scytophylla* Kurokawa, sp. nov.

PLATE 7

Thallus adnatus, corticola, cinereo-albicans, 5–14 cm. diametro, lobis sublinearibus vel subirregularibus, margine subcrenatis, superne planus, nitidus, exigue albomaculatus, isidiis sorediisque destitutus, subtus niger, modice rhizinosus, rhizinis nigris, sparse ramosis. Apothecia adnata, ca. 10 mm. diametro; hymenium 35–40 μ altum; sporae 5–6 \times 8–9 μ .

Thallus adnate to loosely adnate on bark, yellowish glaucous to pale olive gray (R), 5–14 cm. in diameter; lobes irregularly branched, sublinear to subirregular, 2–6 mm. wide, 250–350 μ thick, the margins more or less crenate, narrowly black-rimmed; upper surface plane and smooth, shiny, faintly maculate, isidia and soredia lacking; medulla white; undersurface black, moderately rhizinate, blackish brown and naked or papillate in a narrow zone around the tips, the rhizines black, shiny, sparsely branched. Apothecia adnate to substipitate, often more than 10 cm. in diameter, exciple undulate, amphithecium smooth, faintly maculate, disc warm blackish brown to light seal brown (R); hymenium 35–40 μ high; spores 5–6 \times 8–9 μ .

Reactions: Thallus K+ yellow; medulla K–, C+ rose, KC+ red, P–, atranorine and gyrophoric acid present.

Type in the National Science Museum, Tokyo, collected at Migotang, Sikkim, at 3900 m. elevation, May 30, 1960, by H. Hara (isotype in US).

Parmelia scytophylla is very similar to two other species known only in the Himalayan region, *P. rigidula* Kurokawa and *P. scytodes* Kurokawa. All have rather large coriaceous thalli. *Parmelia scytodes* contains barbatic acid and a P+ unknown, and *P. rigidula* contains a pale-yellow pigment and has larger spores, 15–18 μ long.

Additional specimens examined: Nepal: Langtang Village, *Polunin* M32 (BM). India: Nilgherries, *Watt* s.n. (BM); Darjeeling, *Awasthi* 12 (H).

28. *Parmelia thysanota* Kurokawa, sp. nov.

Thallus laxe adnatus, corticola, cinereo-albicans, 5–13 cm. latus, lobis sublinearibus, subdivaricatis, separatis, 2–5 mm. latis, superne planus, nitidulus, apice leviter albopruinosus, sorediatus, soraliis subterminalibus, subtus niger, dense rhizinosus, rhizinis nigris, dense ramosis. Apothecia ignota.

Thallus loosely adnate on bark, pale-glaucous green (R), 5–13 cm. in diameter; lobes dichotomously branched, linear or sublinear-elongate, subdivaricate, separate at the circumference, 2–5 mm. wide, 140–180 μ thick, the margins entire, narrowly black-rimmed; upper surface plane, rather shiny, often pruinose near the tips, sorediate, soralia laminal and subterminal, often protruding, coalescing; medulla white; undersurface densely rhizinate, black, the rhizines black, shiny, densely branched, usually projecting in a narrow dense mat beyond the margins. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K–, C+ rose, KC+ red, P–, atranorine and gyrophoric acid present.

Type in the United States National Herbarium, collected in pine-oak forest on lava, 11 km. east of Las Vigas on Highway 140, Veracruz, Mexico, Mar. 11, 1960, by M. E. Hale (no. 20943).

Parmelia thysanota is very closely related to *P. exporrecta* Kurokawa in having a subdivaricate thallus and in producing gyrophoric acid. It differs in having subterminal soralia; *P. exporrecta* lacks any soralia. It is probable that these two species represent a sorediate-nonsorediate phase, but the material at hand is not sufficient for a final decision.

Additional specimen examined: Mexico: Same locality data as the holotype, *Hale* 21118 (US).

29. *Parmelia virginica* Hale, sp. nov.

PLATE 5

Thallus adnatus, albido-cinereascens, nonnihil fragilis, corticola, 5–7 cm. diametro, lobis sublinearibus, 1.5–2.5 mm. latis, margine centrum versus paulo lobulato-dissectis, superne nitidus, minute

rugulosus, aetate valde irregulariter rugosus, cortice fragili, pustulescente, sorediis destitutus, subtus niger, modice rhizinosus, rhizinis modice dichotome ramosis. Apothecia ignota.

Thallus adnate, mineral gray, rather fragile, corticolous; lobes sub-linear, 1.5–2.5 mm. wide, 110–130 μ thick, more or less subimbricate, towards the center lobulate-dissected; upper surface shiny, minutely rugulose, strongly rugose with age, the cortex fragile and breaking away, forming coarse pustules, soredia lacking; medulla white; under-surface black, brown near the tips, moderately rhizinate, the rhizines black, moderately branched. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K–, C–, KC+ orange, P–, atranorine, barbatic acid, and an unknown KC+ substance present.

Type in the U.S. National Herbarium, collected at Hawksbill, Shennandoah National Park, Page Co., Virginia, elev. 1200 m., June 26, 1962, by M. Hale (no. 21592; isotypes in DUKE, LD, M, MSC, REN, S, TNS, WISC).

Parmelia virginica is virtually identical with *P. taylorensis* Mitch. (*P. rugosa* Tayl. non Fr.) in regard to the fragile cortex and the development of pustules. The pustules originate along the ridges of wrinkles and are therefore usually elongate. *Parmelia taylorensis* (cf. Mitchell, 1962; Hale, 1962) is typically a European species which differs in having evernic and lecanoric acids and more richly branched rhizines. The type collection of *P. virginica* was made on exposed dwarf spruce trunks. It is probably common in similar habitats in the Appalachians from Virginia through North Carolina.

Additional specimen examined: North Carolina: Lich-Log ridge, Blue Ridge Parkway, McDowell Co., elev. 4660 ft., *Becking* 5908031 (US).

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